ANNEX A
(mandatory)

TESTING PROCEDURES FOR NONAUTOMATIC WEIGHING INSTRUMENTS

A.1 Administrative examination (8.2.1)

Review the documentation that is submitted, including necessary photographs, drawings, relevant technical specifications of main components, etc., to determine if it is adequate and correct. Consider the operational manual.

Note: An “operating manual” may be a draft or an equivalent document for the user.

A.2 Compare construction with documentation (8.2.2)

Examine the various devices of the instrument to ensure compliance with the documentation. Consider also 3.10.

A.3 Initial examination

A.3.1 Metrological characteristics

Note metrological characteristics according to the "Evaluation Report" (see R 76-2).

A.3.2 Descriptive markings (7.1)

Check the descriptive markings according to the check-list given in the Evaluation Report.

A.3.3 Stamping and securing (4.1.2.4 and 7.2)

Check the arrangements for stamping and securing according to the check-list given in the Evaluation Report.

A.4 Performance tests

A.4.1 General conditions

A.4.1.l Normal test conditions (3.5.3.1)

Errors shall be determined under normal test conditions. When the effect of one factor is being evaluated, all other factors are to be held relatively constant, at a value close to normal.

A.4.1.2 Temperature

The tests shall be performed at a steady ambient temperature, usually normal room temperature unless otherwise specified.

The temperature is deemed to be steady when the difference between the extreme temperatures noted during the test does not exceed one-fifth of the temperature range of the given instrument without being greater than 5 °C (2 °C in the case of a creep test), and the rate of change does not exceed 5 °C per hour.

A.4.1.3 Power supply

Instruments using electric power shall normally be connected to the power supply and "on" throughout the tests.

A.4.1.4 Reference position before tests

For an instrument liable to be tilted, the instrument shall be levelled at its reference position.

A.4.1.5 Automatic zero-setting and zero-tracking

During the tests, the effect of the automatic zero-setting device or the zero-tracking device may be switched off or suppressed by starting the test with a load equal to say 10e.

In certain tests where the automatic zero-setting or zero-tracking must be in operation (or not), specific mention of this is made in those test descriptions.

A.4.1.6 Indication with a scale interval smaller than e

If an instrument with digital indication has a device for displaying the indication with a smaller scale interval (not greater than 1/5 e), this device may be used to determine the error. If a device is used it should be noted in the Evaluation Report.

A.4.1.7 Using a simulator to test modules (3.10.2 and 3.7.1)

If a simulator is used to test a module, the repeatability and stability of the simulator should make it possible to determine the performance of the module with at least the same accuracy as when a complete instrument is tested with weights, the mpe to be considered being those applicable to the module. If a simulator is used, this shall be noted in the Evaluation Report and its traceability referenced.

A.4.1.8 Adjustment (4.1.2.5)

A semi-automatic span adjustment device shall be initiated only once before the first test.

An instrument of class I shall, if applicable, be adjusted prior to each test following the instructions in the operating manual.

Note: The temperature test A.5.3.1 is considered as one test.

A.4.1.9 Recovery

After each test the instrument should be allowed to recover sufficiently before the following test.

A.4.1.10 Preloading

Before each weighing test the instrument shall be pre-loaded once to Max or to Lim if this is defined, except for the tests in A.5.2 and A.5.3.2.

Where load cells are tested separately, the pre-loading shall follow OIML R 60.

A.4.1.11 Multiple range instrument

In principle, each range should be tested as a separate instrument. For instruments with automatic change over, however, combined tests can be possible.

A.4.2 Checking of zero

A.4.2.1 Range of zero-setting (4.5.1)

A.4.2.1.1 Initial zero-setting

With the load receptor empty, set the instrument to zero. Place a test load on the load receptor and switch the instrument off and then back on. Continue this process until, after placing a load on the load receptor and switching the instrument on and off, it does not re-zero. The maximum load that can be re-zeroed is the positive portion of the initial zero-setting range.

Remove any load from the load receptor and set the instrument to zero. Then remove the load receptor (platform) from the instrument. If, at this point, the instrument can be reset to zero by switching it off and back on, the mass of the load receptor is used as the negative portion of the initial zero-setting range.

If the instrument cannot be reset to zero with the load receptor removed, add weights to any hive part of the scale (e.g. on the parts where the load receptor rests) until the instrument indicates zero again.

Then remove weights and, after each weight is removed, switch the instrument off and back on. The maximum load that can be removed while the instrument can still be reset to zero by switching it off and on is the negative portion of the initial zero-setting range.

The initial zero-setting range is the sum of the positive and negative portions. If the load receptor cannot readily be removed, only the positive part of the initial zero-setting range need be considered.

A.4.2.1.2 Non-automatic and semi-automatic zero-setting

This test is performed in the same manner as described in A.4.2.1.1, except that the zero-setting means is used rather than switching the instrument off and on.

A.4.2.1.3 Automatic zero-setting

Remove the load receptor as described in A.4.2.1.1 and place weights on the instrument until it indicates zero.

Remove weights in small amounts and after each weight is removed allow time for the automatic zero-setting device to function so as to see if the instrument is reset to zero automatically. Repeat this procedure until the instrument will not reset to zero automatically.

The maximum load that can be removed so that the instrument can still be reset to zero, is the zero-setting range.

If the load receptor cannot readily be removed, a practical approach can be to add weights to the instrument and use another zero-setting device, if provided, to set the instrument to zero. Then remove weights and check whether the automatic zero-setting still sets the instrument to zero. The maximum load that can be removed so that the instrument can still be reset to zero is the zero-setting range.

A.4.2.2 Zero indicating device (4.5.5)

For instruments <u>fitted with a zero indicating device and</u> digital indication, adjust the instrument to about one scale interval below zero; then by adding weights equivalent to say 1/10 of the scale interval, determine the range over which the zero indicating device indicates the deviation from zero.

A.4.2.3 Accuracy of zero-setting (4.5.2)

<u>The test may be combined with A.4.4.1</u>

A.4.2.3.1 Non-automatic and semi-automatic zero-setting

The accuracy of the zero-setting device is tested by first loading the instrument to an indication as close as possible to a changeover point, and then by initiating the zero-setting device and determining the additional load at which the indication changes from zero to one scale interval above zero. The error at zero is calculated according to the description in A.4.4.3.

A.4.2.3.2 Automatic zero-setting or zero-tracking

The indication is brought out of the automatic range (e.g. by loading with 10 e). Then the additional load at which the indication changes from one scale interval to the next above is determined and the error is calculated according to the description in A.4.4.3. It is assumed that the error at zero load would be equal to the error at the load in question.

A.4.3 Setting to zero before loading

For instruments with digital indication, the adjustment to zero, or the determination of the zero point is carried out as follows:

a) for instruments with non-automatic zero-setting, weights equivalent to half a scale interval are placed on the load receptor, and the instrument is adjusted until the indication alternates between zero and one scale interval. Then weights equivalent to half a scale interval are removed from the load receptor to attain a center of zero reference position;

b) for instruments with semi-automatic or automatic zero-setting or zero-tracking, the deviation from zero is determined as described in A.4.2.3.

A.4.4 Determination of weighing performance

A.4.4.1 Weighing test

Apply test loads from zero up to and including Max, and similarly remove the test loads back to zero. When determining the initial intrinsic error, at least 10 different test loads shall be selected, and for other weighing tests at least 5 shall be selected. The test loads selected shall include Max and Min (Min only if Min ≥ 1 mg) and values at or near those at which the maximum permissible error (mpe) changes.

During type examination it should be noted that when loading or unloading weights the load shall be progressively increased or progressively decreased. It is recommended to apply the same procedure as far as possible during initial verification (8.3) and subsequent metrological control (8.4).

If the instrument is provided with an automatic zero-setting or zero-tracking device, it may be in operation during the tests, except for the temperature test. The error at zero point is then determined according to A.4.2.3.2.

A.4.4.2 Supplementary weighing test (4.5.1)

For instruments with an initial zero-setting device with a range greater than 20 % of Max, a supplementary weighing test shall be performed using the upper limit of the range as zero point.

A.4.4.3 Evaluation of error (A.4.1.6)

For instruments with digital indication and without a device for displaying the indication with a smaller scale interval (not greater than 1/5 e), the changeover points are to be used to determine the indication of the instrument, prior to rounding, as follows.

At a certain load, L, the indicated value, I, is noted. Additional weights of say 1/10 e are successively added until the indication of the instrument is increased unambiguously by one scale interval (I + e). The additional load ΔL added to the load receptor gives the indication P, prior to rounding by using the following formula:

$$P = I + 1/2\ e - \Delta L$$

The error prior to rounding is:

$$E = P - L = I + 1/2\ e - \Delta L - L$$

The corrected error prior to rounding is:

$$E_c = E - E_0 \leq mpe$$

where E_0 is the error calculated at zero or at a load close to zero (e.g. 10 e).

Example: an instrument with a scale interval, e, of 5 g is loaded with 1 kg and thereby indicates 1 000 g. After adding successive weights of 0.5 g, the indication changes from 1 000 g to 1 005 g at an additional load of 1.5 g. Inserted in the above formula these observations give:

$$P = (1\ 000 + 2.5 - 1.5)\ g = 1\ 001\ g$$

Thus the true indication prior to rounding is 1 001 g, and the error is:

$$E = (1\ 001 - 1\ 000)\ g = + 1\ g$$

If the changeover point at zero as calculated above was $E_0 = + 0.5$ g, the corrected error is:

$$E_c = + 1 - (+0.5) = + 0.5\ g$$

In the tests A.4.2.3 and A.4.11.1, the error shall be determined with a sufficient accuracy in view of the tolerance in question.

Note: The above description and formulae arc valid also for multi-interval instruments. Where the load L and the indication I are in different partial weighing ranges:

- the additional weights ΔL are to be in steps of 1/10 of e_i,

- in the equation "E = P - L = ..." above, the term "1/2 e" is to be 1/2 e_i or 1/2 e_{i+1} according to the partial weighing range in which the indication (I + e) is appearing.

A.4.4.4 Testing of modules

When testing modules separately, it shall be possible to determine the errors with a sufficiently small uncertainty considering the chosen fractions of the mpe either by using a device for displaying the indication with a scale interval smaller than (1/5) $p_i \cdot e$ or by evaluating the change-over point of the indication with an uncertainty better than (1/5) $p_i \cdot e$.

A.4.4.5 Weighing test using substitution material (3.7.3)

The test shall be carried out only during verification and at the place of use taking A.4.4.1 into account.

Determine the allowed number of substitutions according to 3.7.3.

Check the repeatability error at a load of about the value where the substitution is made, by placing it 3 times on the load receptor.

Apply test loads from zero up to and including maximum portion of standard weights.

Determine the error (A.4.4.3) and then remove the weights so that the no-load indication, or, in the case of an instrument with a zero-tracking device, the indication of say 10 e, is reached.

Substitute the previous weights with substitution material until the same changeover point, as used for the determination of the error, is reached. Repeat the above procedure until Max of the instrument is reached.

Unload in reverse order to zero, i.e. unload the weights and determine the change-over point. Place the weights back and remove the substitution material until the same changeover point is reached. Repeat this procedure until no-load indication.

Similar equivalent procedures may be applied.

A.4.5 Instrument with more than one indicating device (3.6.3)

If the instrument has more than one indicating device, the indications of the various devices shall be compared during the tests described in A.4.4.

A.4.6 Tare

A.4.6.1 Weighing test (3.5.3.3)

Weighing tests (loading and unloading according to A.4.4.1) shall be performed with different tare values. At least 5 load steps shall be selected. The steps shall include values close to Min, values at or near those at which the maximum permissible error (mpe) changes and the value close to the maximum possible net load.

The weighing tests should be performed on instruments with

- subtractive tare: with one tare value between 1/3 and 2/3 of maximum tare,
- additive tare: with two tare values of about 1/3 and 3/3 of maximum tare weight.

In case of 8.3 and 8.4 the practical test may be alternatively replaced by other appropriate procedures, eg. by numerical or graphical considerations.

If the instrument is provided with automatic zero-setting or zero-tracking device it may be in operation during the test, in which case the error at zero point shall be determined according to A.4.2.3.2.

A.4.6.2 Accuracy of tare setting (4.6.3)

The test may be combined with A.4.4.1

The accuracy of the tare device shall be established in a manner similar to the test described in A.4.2.3 with the indication set to zero using the tare device.

A.4.6.3 Tare weighing device (3.5.3.4 and 3.6.3)

If the instrument has a tare weighing device, the results obtained for the same load (tare), by the tare weighing device and the indicating device, shall be compared.

A.4.7 Eccentricity tests (3.6.2)

Large weights should be used in preference to several small weights. Smaller weights shall be placed on top of larger weights, but unnecessary stacking should be avoided within the segment to be tested. The load shall be applied centrally in the segment if a single weight is used, but applied uniformly over the segment, if several small weights are used. It is sufficient to apply the load only to the eccentric segments, not to centre of the load receptor.

Note: If an instrument is designed in such a way that loads may be applied in different manners, it may be appropriate to apply more than one of the tests described in A.4.7.1 through A.4.7.5.

The location of the load shall be marked on a sketch in the Type Evaluation Report.

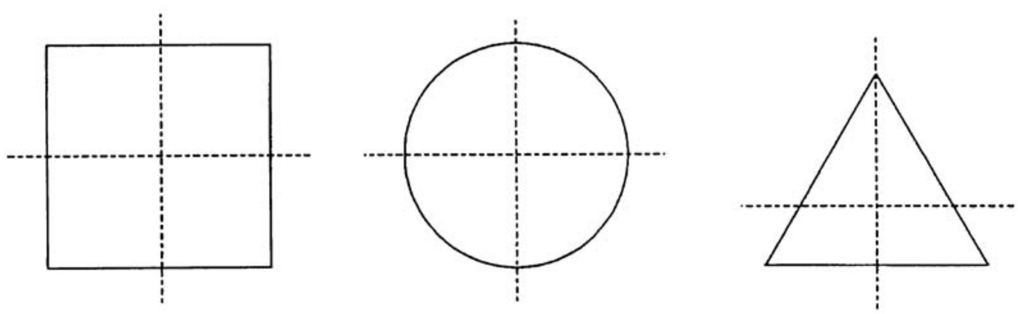
The error at each measurement is determined according to A.4.4.3. The zero error E_0 used for the correction is the value determined prior to each measurement. Normally it is sufficient to determine the zero error only at the beginning of the measurement, but on special instruments (class I, high capacity, etc.) it is recommended that the zero error be determined prior to each eccentricity loading. However in case of bad results the test with zero error prior to each loading is necessary.

If the instrument is provided with automatic zero-setting or zero-tracking, it shall not be in operation during the following tests.

A.4.7.1 Instrument with a load receptor having not more than four points of support

The four quarter segments roughly equal to 1/4 of the surface of the load receptor (as per the sketches in Figure 8 or similar sketches) shall be loaded in turn.

Figure 8



Examples: A load receptor which transmits the force from the load
- directly into 4 load cells has 4 points of support,
- with 6 mechanical connection elements into a lever works has 6 points of support
- directly into 1 single point load cell has 1 point of support.

A.4.7.2 Instrument with a load receptor having more than four points of support

The load shall be applied over each support on an area of the same order of magnitude as the fraction 1/n of the surface area of the load receptor, where n is the number of points of support.

Where two points of support are too close together for the above-mentioned test load to be distributed as indicated above, the load shall be doubled and distributed over twice the area on both sides of the axis connecting the two points of support.

A.4.7.3 Instrument with special load receptors (tank, hopper, etc.)

The load shall be applied to each point of support.

A.4.7.4 Instrument used for weighing rolling loads (3.6.2.4)

A rolling load shall be applied at different positions on the load receptor. These positions shall be at the beginning, the middle and at the end of the load receptor in the normal driving direction. The positions shall then be repeated in the reverse direction, if the application in both directions is possible. Before changing direction zero has to be determined again.

A.4.7.5 Eccentricity tests for mobile instruments

A.4.7 and A.4.7.1 to A.4.7.4 should be applied as far as these points are applicable. If not, the positions of the test loads during this test have to be defined according to the operational conditions of use. As an extreme, if operating conditions are such that no eccentricity can occur, eccentricity tests need not be performed at all.

A.4.8 Discrimination test (3.8)

The following tests shall be performed with three different loads, e.g. Min, 1/2 Max and Max.

A.4.8.1 Non-self-indication and analogue indication

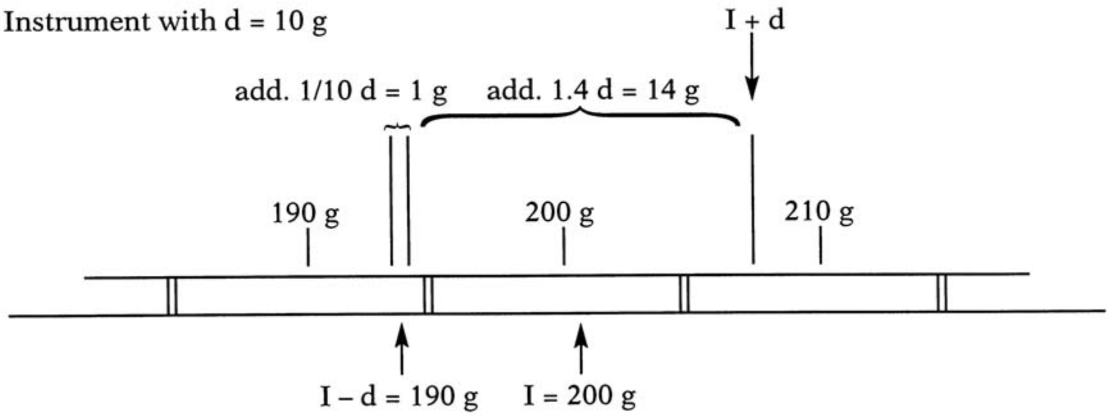
An extra load, but not less than 1 mg, shall be placed gently on or removed from the load receptor while the instrument is at equilibrium. For certain extra load the equilibrium mechanism shall assume a different position of equilibrium, as specified.

A.4.8.2 Digital indication

This test applies only to type examination and to instruments with $d \geq 5$ mg.

A load plus sufficient additional weights (say 10 times 1/10 d) shall be placed on the load receptor. The additional weights shall then be removed successively until the indication, I, is decreased unambiguously by one actual scale interval, I - d. One of the additional weights shall be replaced and a load equal to 1.4 d shall then be gently placed on the load receptor and give a result increased by one actual scale interval above the initial indication, I + d. See example in Figure 9.

Figure 9



The indication at the start is I = 200 g. Remove additional weights until the indication changes to I - d = 190 g. Add 1/10 d = 1 g and thereafter 1.4 d = 14 g. The indication shall then be I + d = 210 g.

A.4.9 Sensitivity of a non-self-indicating instrument (6.1)

During this test the instrument shall oscillate normally, and an extra load equal to the value of the mpe for the applied load, but not less than 1 mg, shall be placed on the instrument while the load receptor is still oscillating. For damped instruments the extra load shall be applied with a slight impact. The linear distance between the middle points of this reading and the reading without the extra load shall be taken as the permanent displacement of the indication. The test shall be performed with a minimum of two different loads (e.g. zero and Max).

A.4.10 Repeatability test (3.6.1)

For type approval two series of weighings shall be performed, one with a load of about 50 % and one with a load close to 100 % of Max. For instruments with Max less than 1 000 kg each series shall consist of 10 weighings. In other cases each series shall consist of at least 3 weighings. Readings shall be taken when the instrument is loaded, and when the unloaded instrument has come to rest between weighings. In the case of a zero deviation between the weighings, the instrument shall be reset to zero, without determining the error at zero. The true zero position need not be determined between the weighings.

If the instrument is provided with automatic zero-setting or zero-tracking, it shall be in operation during the test.

For initial verification one test with about 0.8 of Max is sufficient. Normally no more than 3 weighings on classes III and IIII or 6 weighings on classes I and II are necessary.

A.4.11 Variation of indication with time (for instruments of class II, III or IIII only)

A.4.11.1 Creep test (3.9.4.1)

Load the instrument close to Max. Take one reading as soon as the indication has stabilized and then note the indication while the load remains on the instrument for a period of four hours. During this test the temperature should not vary more than 2 °C.

The test may be terminated after 30 minutes if the indication differs less than 0.5 e during the first 30 minutes and the difference between 15 and 30 minutes is less than 0.2 e.

A.4.11.2 Zero return test (3.9.4.2)

The deviation in the zero indication before and after a period of loading with a load close to Max for half an hour, shall be determined. The reading shall be taken as soon as the indication has stabilized.

For multiple range instruments, continue to read the zero indication during the following 5 minutes after the indication has stabilized.

If the instrument is provided with automatic zero-setting or zero-tracking, it shall not be in operation.

A.4.12 Test for the stability of equilibrium (4.4.2)

Check whether under continuous disturbance of the equilibrium no functions can be performed that require stable equilibrium, eg. printing, storing, zero or tare operations.

Load the instrument up to 50 % of Max or up to a load included in the range of operation of the relevant function. Manually disturb the equilibrium by one single action and initiate the command for printing, data storage, or other function, as soon as possible. In the case of printing or data storage, read the indicated value over a period of 5 seconds following print-out. Stable equilibrium is considered to be achieved when no more than two adjacent values are indicated, one of which being the printed value. For instruments with differentiated scale divisions, this paragraph applies to "e" rather than "d".

In the case of zero-setting or tare balancing, check the accuracy as per A.4.2.3/A.4.6.2. Perform the test 5 times.

In case of vehicle mounted, vehicle integrated or mobile instruments, tests have to be performed with a known operational test load, the instrument being in motion to insure either that the stability criteria inhibit any weighing operation or that the stable equilibrium criteria of 4.4.2 are met.

In case the instrument can be used to weigh liquid products in a vehicle, tests should be performed in conditions where the vehicle is stopped just before testing so that either the stability criteria inhibit any weighing operation or that the stable equilibrium criteria of 4.4.2 are met.

A.4.13 Tests on the evenness of the mounting surface for portable weighbridges

To be performed during type approval :

- At a site agreed with the manufacturer:
  * to examine the evenness of the reference area (all points of support of the bridge being at the same level) and then, to perform an accuracy test and an eccentricity test
  * to realise several reference areas with some different faults in the evenness (values of these faults are to be equal to the limits given by the manufacturer) and then, to perform an eccentricity test for each configuration
- On a site of use:
  * to examine the conformity to the requirements for the mounting surface
  * to examine the installation and to perform tests to establish conformity to the metrological requirements.

A.5 Influence factors

A.5.1 Tilting (only class (II), (III) and (IIII) instruments) (3.9.1.1)

The instrument shall be tilted both forwards and backwards longitudinally, and from side to side, transversely

In the text that follows, class (II) instruments intended for direct sales to the public are designated class (II)* and class (II) instruments not intended for direct sales to the public are designated class (II).

In practice the tests (no-load and loaded) described in A.5.1.1.1 and A. 5.1.1.2 can be combined as follows.

After zero-setting in the reference position, the indication (prior to rounding) is determined at no load and at the two test loads. The instrument is then unloaded and tilted (without a new zero-setting), after which the indications at no load and at the two test loads are determined. This procedure is repeated for each of the tilting directions.

In order to determine the influence of tilting on the loaded instrument, the indication obtained at each tilt shall be corrected for the deviation from zero which the instrument had prior to loading.

If the instrument is provided with automatic zero-setting or zero-tracking, it shall not be in operation.

A.5.1.1 Tilting of instruments with a level indicator or automatic tilt sensor (3.9.1.1, a. and b.)

A.5.1.1.1 Tilting at no-load

The instrument shall be set to zero in its reference position (not tilted). The instrument shall then be tilted longitudinally up to the limiting value of tilting. The zero indication is noted. The test shall be repeated with transverse tilting.

A.5.1.1.2 Tilting when loaded

The instrument shall be set to zero in its reference position and two weighings shall be carried out at a load close to the lowest load where the maximum permissible error changes, and at a load close to Max. The instrument is then unloaded and tilted longitudinally and set to zero. The tilting shall be equal to the limiting value of tilting. Weighing tests as described above shall be performed. The test shall be repeated with transverse tilting.

A.5.1.2 Other instrument (3.9.1.1, c.)

For instruments liable to be tilted and neither be fitted with a level indicator nor with an automatic tilt sensor the tests in A.5.1.1 shall be performed with a tilting of 50/1000 or, in case of an instrument with automatic tilt sensor, with a tilting equal to the limiting value of tilting as defined by the manufacturer.

A.5.1.3 Tilt test for mobile instruments used outside in open locations (3.9.1.1, d.)

Appropriate load receptors for applying the test loads are to be provided by the applicant.

The tilt test shall be performed with the limiting value of tilting as specified by the applicant.

The instrument shall be tilted both forwards and backwards longitudinally, and from side to side, transversely.

Functional tests shall be performed to ensure that, if applicable, tilt sensors or inclination switches function properly especially when generating the signal that the maximum permissible tilt is reached or exceeded (eg. display switch-off, error signal, lamp), and inhibiting transmission and printing of weighing results.

To reach the switching-off point, the instrument must be tilted as long as the indication of the instrument is not yet switched off.

If the instrument is provided with automatic zero-setting or zero-tracking, it shall not be in operation.

The instrument shall be tested according to A.5.1 and A.5.1.1 or A.5.1.2.

A.5.2 Warm-up time test (5.3.5)

An instrument using electric power shall be disconnected from the supply for a period of at least 8 hours prior to the test. The instrument shall then be connected and switched on and as soon as the
indication has stabilized, the instrument shall be set to zero and the error at zero shall be determined. Calculation of error shall be made according to A.4.4.3. The instrument shall be loaded with a load close to Max. These observations shall be repeated after 5, 15 and 30 minutes. Every individual measurement performed after 5, 15, and 30 minutes, shall be corrected for the zero error at that time.

For instruments of class (I), the provisions of the operating manual for the time following connection to the mains shall be observed.

A.5.3 Temperature tests
(see Figure 10 as a practical approach to performing the temperature tests)

A.5.3.1 Static temperatures (3.9.2.1 and 3.9.2.2)

The test consists of exposure of the equipment under test (EUT) to constant (see A.4.1.2) temperatures within the range stated in 3.9.2, under free air conditions, for a 2 hour period after the EUT has reached temperature stability.

The weighing tests (loading and unloading) shall be carried out according to A.4.4.l:

- at a reference temperature (normally 20 °C but for class I instruments the mean value of the specified temperature limits),
- at the specified high temperature,
- at the specified low temperature,
- at a temperature of 5 °C, if the specified low temperature is ≤ 0 °C, and
- at the reference temperature.

The change of temperature shall not exceed 1 ^{0}C/min during heating and cooling down.

For class I instruments, changes in barometric pressure shall be taken into account.

The absolute humidity of the test atmosphere shall not exceed 20 g/m^3, unless the operating manual gives different specifications.

Reference to IEC Publications: see Bibliography /1/ (See preliminary note to Annex B.)

A.5.3.2 Temperature effect on the no-load indication (3.9.2.3)

The instrument shall be set to zero and then changed to the prescribed highest and lowest temperatures as well as at 5 °C if applicable. After stabilisation the error of the zero indication shall be determined. The change in zero indication per 1 °C (class I instruments) or per 5 °C (other instruments) shall be calculated. The changes of these errors per 1 °C (class I instruments) or per 5 °C (other instruments) shall be calculated for any two consecutive temperatures of this test.

This test may be performed together with the temperature test (A 5.3.1). The errors at zero shall then be additionally determined immediately before changing to the next temperature and after the 2 hour period after the instrument has reached stability at this temperature.

Note: Preloading is not allowed before these measurements.

If the instrument is provided with automatic zero-setting or zero-tracking, it shall not be in operation.

A.5.4 Voltage variations (3.9.3)

Stabilize the EUT under constant environmental conditions.

The test consists of subjecting the EUT to variations of AC mains voltage.

The test shall be performed with test loads of 10 e and a load between 1/2 Max and Max.

If the instrument is provided with an automatic zero-setting device or a zero-tracking device, it may be in operation during the test, in which case the error at zero point shall be determined according to A.4.2.3.2.

A.5.4.1 Variations of AC mains voltage

Test severity: Voltage variations: upper limit V + 10 %
lower limit V - 15 %
where V is the value marked on the instrument; if a range of voltages (V_{min}, V_{max}) is marked then the test shall be performed at V_{max} + 10 % and V_{min} - 15%.

Maximum allowable variations: All functions shall operate as designed.
All indications shall be within the maximum permissible errors.

Note: Where an instrument is powered by a three phase supply, the voltage variations shall apply for each phase successively.

A.5.4.2 Variations of external or plug-in power supply (AC or DC) or battery operated instruments

Test severity: Voltage variations: upper limit: V + 20 %
lower limit: minimum operating voltage (see 3.9.3)
where V is the value marked on the instrument; if a range of voltages (V_{min}, V_{max}) is marked then the test shall be performed at V_{max} + 20 % and at the minimum operating voltage.

Maximum allowable variations: All functions shall operate as designed or the indication shall switch off.
All indications shall be within the maximum permissible errors

A.5.4.3 Voltage variations of a road vehicle battery

For specifications of the power supply used during the test to simulate the battery, refer to ISO 7637-2, clause 4.4 [31]

Test severity: Voltage variations: upper limit 12 V: 14,5 V
upper limit 24 V: 29 V
upper limit of other batteries: nominal voltage + 20 %
lower limit: minimum operating voltage (see 3.9.3)

Maximum allowable variations: All functions shall operate as designed or the indication shall switch off.
All indications shall be within the maximum permissible errors

A.6 Endurance test (3.9.4.3)

(applicable only to instruments of class II, III and IIII with Max ≤ 100 kg)

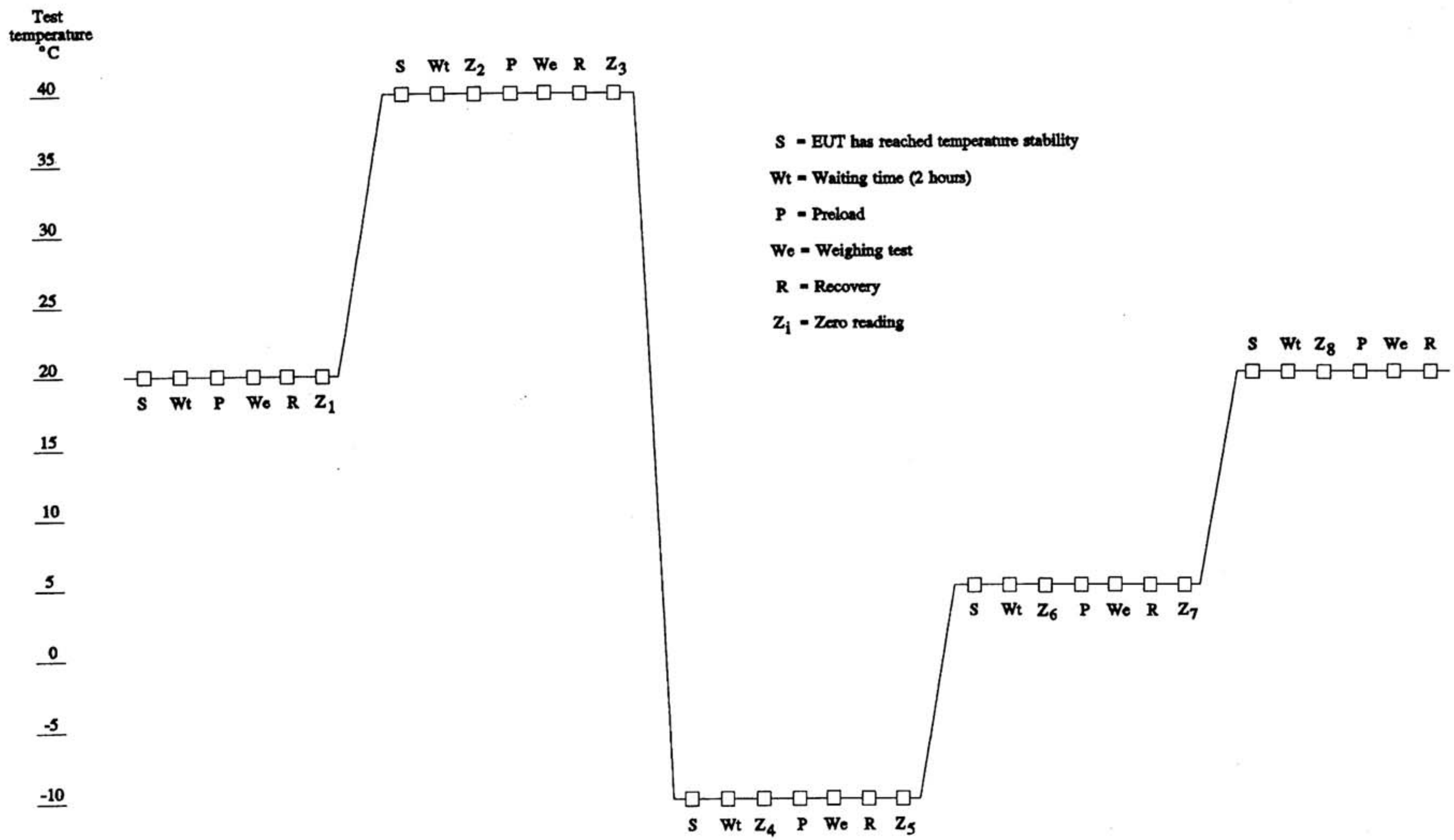
The endurance test shall be performed after all other tests.

Under normal conditions of use, the instrument shall be subjected to the repetitive loading and unloading of a load approximately equal to 50 % of Max. The load shall be applied 100 000 times. The frequency and speed of application shall be such that the instrument attains an equilibrium when loaded and when unloaded. The force of the load applied shall not exceed the force attained in a normal loading operation.

A weighing test in accordance with the procedure in A.4.4.1 shall be performed before the endurance test is started to obtain the intrinsic error. A weighing test shall be performed after the completion of the loadings to determine the durability error due to wear and tear.

If the instrument is provided with automatic zero-setting or zero-tracking device it may be in operation during the test, in which case the error at zero point shall be determined according to A.4.2.3.2.

Figure 10
Proposed test sequence for test A.5.3.1 combined with A.5.3.2
(temperature test where the temperature limits are + 40 °C / – 10 °C)



ANNEX B
(mandatory)

ADDITIONAL TESTS FOR ELECTRONIC INSTRUMENTS

Preliminary note: The tests which are specific to electronic instruments, as described in this Annex, have been taken as far as possible from the work of the International Electrotechnical Commission (IEC) taking also in consideration the third draft revision of the OIML International Document D11 "General Requirements for Electronic Measuring Instruments".

B.1 General requirements for electronic instruments under test (EUT)

Energize the EUT for a time period equal to or greater than the warm-up time specified by the manufacturer and maintain the EUT energized for the duration of the test.

Adjust the EUT as closely as practicable to zero prior to each test, and do not readjust it at any time during the test, except to reset it if a significant fault has been indicated. The deviation of the no-load indication due to any test condition shall be recorded, and any load indication shall be corrected accordingly to obtain the weighing result.

The handling of the instrument shall be such that no condensation of water occurs on the instrument.

B.2 Performance tests for influence factors

B.2.1 Static temperatures: see A.5.3.

B.2.2 Damp heat, steady state

(not applicable to class I instruments or class II instruments where e is less than 1 gram)

Test procedure in brief: The test consists of exposure of the EUT to a constant (*) temperature and a constant relative humidity The EUT shall be tested with at least five different test loads (or simulated loads):

- at the reference temperature (20 °C or the mean value of the temperature range whenever 20 °C is outside this range) and a relative humidity of 50 % following conditioning,
- at the high temperature of the range specified in 3.9.2 and a relative humidity of 85 %, two days following temperature and humidity stabilization, and
- at the reference temperature and relative humidity of 50%.

(*) See A.4.1.2.

Maximum allowable variations:	All functions shall operate as designed. All indications shall be within maximum permissible errors.
Reference to IEC Publications:	see Bibliography /2/

B.2.3 Power voltage variations: see A.5.4.

B.3 Performance tests for disturbances

Prior to any test, the rounding error shall be set as chose as possible to zero.

If there are interfaces on the instrument, an appropriate peripheral device shall be connected to each different type of interface during the tests.

For all tests note the environmental conditions at which they were realised

Energize the EUT for a time period equal to or greater than the warm-up time specified by the manufacturer and maintain the EUT energized for the duration of the test.

Adjust the EUT as closely as practicable to zero prior to each test, and do not readjust it at any time during the test, except to reset it if a significant fault has been indicated. The deviation of the no-load indication due to any test condition shall be recorded, and any load indication shall be corrected accordingly to obtain the weighing result.

The handling of the instrument shall be such that no condensation of water occurs on the instrument.

Necessary additional or alternative disturbance tests for NAWIs powered from the vehicle battery are to be conducted according to ISO 7637.

B.3.1 Short time power reductions

Test procedure in brief:	Stabilize the EUT under constant environmental conditions. A test generator suitable to reduce for a defined period of time the amplitude of one or more half cycles (at zero crossings) of the AC mains voltage shall be used. The test generator shall be verified before connecting the EUT. The mains voltage reductions shall be repeated ten times with an interval of at least 10 seconds. The test shall be performed with one small test load.
Test severity:	Reduction 100 % 60 % 30%

Number of half cycles	250	5	0,5

Maximum allowable variations: The difference between the weight indication due to the disturbance and the indication without the disturbance shall either not exceed e or the instrument shall detect and react to a significant fault.

B.3.2 Bursts

The test consists in exposing the EUT to specified bursts of voltage spikes for which the repetition frequency of the impulses and peak values of the output voltage on 50 ohms and 1000 ohms load are defined in the referred standard. The characteristics of the generator shall be verified before connecting the EUT.

Before any test stabilize the EUT under constant environmental conditions.

The test shall be applied separately to:
- power supply lines,
- I/O circuits and communication lines, if any.

The test shall be performed with one small test load.

Both positive and negative polarity of the bursts shall be applied. The duration of the test shall not be less than one min for each amplitude and polarity. The injection network on the mains shall contain blocking filters to prevent the burst energy being dissipated in the mains. For the coupling of the bursts into the input/output and communication lines, a capacitive coupling clamp as defined in the standard shall be used.

Test severity: Level 2
Amplitude (peak value)
- power supply lines: 1 kV,
- I/O signal, data and control lines: 0.5 kV.

Maximum allowable variations: The difference between the weight indication due to the disturbance and the indication without the disturbance shall either not exceed e or the instrument shall detect and react to a significant fault.

Reference to IEC Publications: see Bibliography /3/ / Applicable standards 61000-4-1 and
61000-4-4 (see bibliography)

B.3.3 Surge

The test consists of exposure to surges for which the rise time, pulse width, peak values of the output voltage/current on high/low impedance load and minimum time interval between two successive pulses are defined in the referred standard. The characteristics of the generator shall be verified before connecting the EUT.

Before any test stabilize the EUT under constant environmental conditions.

The test shall be applied to:

- power supply lines.
  On AC mains supply lines at least 3 positive and 3 negative surges shall be applied synchronously with AC supply voltage in angles 0°, 90°, 180° and 270°. On any other kind of power supply at least 3 positive and 3 negative surges shall be applied.

The test shall be performed with one small test load.

Both positive and negative polarity of the surges shall be applied. The duration of the test shall not be less than one min for each amplitude and polarity. The injection network on the mains shall contain blocking filters to prevent the surge energy being dissipated in the mains.

Test severity:	Level 2 Amplitude (peak value) power supply lines: 0,5 kV,
Maximum allowable variations:	The difference between the weight indication due to the disturbance and the indication without the disturbance shall either not exceed e or the instrument shall detect and react to a significant fault.
Reference to IEC Publications:	see Bibliography /4/ / Applicable standard 61000-4-5 (see bibliography)

B.3.4 Electrostatic discharge

The test consists in exposing the EUT to specified, direct and indirect, electrostatic discharges.

An ESD generator shall be used with a performance as defined in the referred standard. Before starting the tests, the performance of the generator shall be verified.

This test includes the paint penetration method, if appropriate.

For direct discharges the air discharge shall be used where the contact discharge method cannot be applied.

Before any test stabilize the EUT under constant environmental conditions.

At least 10 discharges shall be applied. The time interval between successive discharges shall be at least 10 seconds. The test shall be performed with one small test load.

For EUT not equipped with ground terminal, the EUT shall be fully discharged between discharges.
Contact discharges shall be applied on conductive surfaces; air discharges shall be applied on non-conductive surfaces.
Direct application :
In the contact discharges mode the electrode shall be in contact with the EUT. In the air discharge mode the electrode is approached to the EUT and the discharge occurs by spark.
Indirect application : The discharges are applied in the contact mode to coupling planes

mounted in the vicinity of the EUT.

Test severity:	Level 3 (see IEC 61000-4-2) DC voltage up to and including 4 kV for contact discharges and 8 kV for air discharges.
Maximum allowable variations:	The difference between the weight indication due to the disturbance and the indication without the disturbance shall either not exceed e or the instrument shall detect and react to a significant fault.
Reference to IEC Publications:	see Bibliography /4/

B.3.5 Immunity to radiated electromagnetic fields

The test consists in exposing the EUT to specified electromagnetic fields.

Test equipment:	See IEC 61000-4-3
Test set-up:	See IEC 61000-4-3
Test procedure:	See IEC 61000-4-3

Before any test, stabilize the EUT under constant environmental conditions.

The EUT shall be exposed to electromagnetic fields of the strength and character as specified by the severity level.

The test shall be performed with one small test load only.

Test severity: Acccording to IEC 61000-6-2, (however Note 3 to Table 1 of IEC 61000-6-2 shall not be considered). Radiation shall be applied only on the most sensitive side of the instrument..

Frequency range	:	80 – 1 000 and 1400 - 2000	MHz
Field strength	:	10 (3*)	V/m
Modulation	:	80 % AM, 1kHz sine wave	

*For instruments that are definitely used in commercial or residential environment only (e.g. instruments for direct sales to the public) the test severity may be chosen according to IEC 61000-6-1

Maximum allowable variations:	The difference between the weight indication due to the disturbance and the indication without the disturbance either shall not exceed e or the instrument shall detect and react to a significant fault.
Reference to IEC Publications:	see Bibliography /4/

B.3.6 Immunity to conducted disturbances, induced by radio-frequency fields

The test consists in exposing the EUT to conducted disturbances, induced by radio-frequency fields.

Test equipment:	See IEC 61000-4-6
Test set-up:	See IEC 61000-4-6
Test procedure:	See IEC 61000-4-6

Before any test, stabilize the EUT under constant environmental conditions.

The EUT shall be exposed to conducted disturbances of the strength and character as specified by the severity level.

The test shall be performed with one small test load only.

Test severity: Acccording to IEC 61000-6-2, (however Note 3 to Table 1 of IEC 61000-6-2 shall not be considered). Radiation shall be applied only on the most sensitive side of the instrument..

Frequency range	:	0,15 – 80	MHz
Field strength	:	10 (3*)	V_{EMF}
Modulation	:	80 % AM, 1kHz sine wave	

*For instruments that are definitely used in commercial or residential environment only (e.g. instruments for direct sales to the public) the test severity may be chosen according to IEC 61000-6-1

Maximum allowable variations: The difference between the weight indication due to the disturbance and the indication without the disturbance either shall not exceed e or the instrument shall detect and react to a significant fault.

Reference to IEC Publications: see Bibliography /4/

Note: Although references to current versions of IEC publication have been made all EMC tests should be conducted on basis of the most recent versions valid at the time of testing. The objective is to keep pace with future technical developments.

B.3.7 Special EMC requirements for road vehicles

B.3.7.1 Electrical transient conduction along supply line of external 12 V and 24 V batteries

The test consists in exposing the EUT to conducted transient disturbances along supply lines.

Applicable standard: ISO 7637-2.3 (2003)

Before any test, stabilize the EUT under constant environmental conditions.

The EUT shall be exposed to conducted disturbances of the strength and character as specified by the severity level.

The test shall be performed with one small test load only.

Test severity: according to ISO 7637-2.3

Test pulses	:	Test pulse 1, 2a+2b, 3a+3b, 4
Objective of the test	:	To verify compliance with the provisions mentioned under "maximum allowable variations" under the following conditions: - transients on the supply lines due to supply disconnection from inductive loads (pulse 1); - transients due to a sudden interruption of currents in a device connected in parallel with the device under test due to the inductance of the wiring harness (pulse 2a); - transients from DC motors acting as generators after the ignition is switched off (pulse 2b); - transients on the supply lines , which occur as a result of the switching processes (pulses 3a and 3b); - voltage reductions caused by energizing the starter-motor circuits of internal combustion engines (pulse 4).

Maximum allowable variations: The difference between the weight indication due to the disturbance and the indication without the disturbance either shall not exceed e or the instrument shall detect and react to a significant fault.

B.3.7.2 Electrical transient transmission by capacitive and inductive coupling via lines other than supply lines

The test consists in exposing the EUT to conducted disturbances.

Test equipment: See ISO 7637-2.3
Test set-up: See ISO 7637-2.3
Test procedure: See ISO 7637-2.3

Before any test, stabilize the EUT under constant environmental conditions.

The EUT shall be exposed to conducted disturbances of the strength and character as specified by the severity level.

The test shall be performed with one small test load only.

Test severity: according to ISO 7637-2.3

Test pulses : Test pulses a and b

Objective of the test : To verify compliance with the provisions mentioned under "maximum allowable variations" under conditions of transients which occur on other lines as a result of the switching processes (pulses a and b)

Maximum allowable variations: The difference between the weight indication due to the disturbance and the indication without the disturbance either shall not exceed e or the instrument shall detect and react to a significant fault.

Reference to ISO Publications: see Bibliography /5/

B.4 Span stability test

(not applicable to class I instruments)

Test procedure in brief: The test consist in observing the variations of the error of the EUT under sufficiently constant ambient conditions (reasonably constant conditions in a normal laboratory environment) at various intervals before, during and after the EUT has been subjected to performance tests. For instruments with incorporated span adjustment device the device shall be activated during this test before each measurement in order to proof its stability and its intended use.

The performance tests shall include the temperature test and, if applicable, the damp heat test; they shall not include any endurance test; other performance tests in Annexes A and B may be performed.

The EUT shall be disconnected from the mains power supply, or battery supply where fitted, two times for at least 8 hours during the period of the test. The number of disconnections may be increased if the manufacturer specifies so or at the discretion of the approval authority in the absence of any such specification.

For the conduct of this test the manufacturer’s operating instructions shall be considered.

The EUT shall be stabilized at sufficiently constant ambient conditions after switch-on for at least 5 hours, but at least 16 hours after the temperature and damp heat tests have been performed.

Test duration: 28 days or the period necessary for the performance tests to be carried out, whichever is shorter.

Time between measurements: Between 1/2 and 10 days, with a fairly even distribution of the measurements over the total duration of the test.

Test load: Near Max; the same test weights shall be used throughout this test.

Number of measurements: At least 8.

Test sequence: Stabilize all factors at sufficiently constant ambient conditions.

Adjust the EUT as close to zero as possible.

Automatic zero-tracking shall be made inoperative and automatic built-in span adjustment device shall be made operative.

Apply the test weight(s) and determine the error.

At the first measurement immediately repeat zeroing and loading four times to determine the average value of the error. For the next measurements perform only one, unless either the result is outside the specified tolerance or the range of the five readings of the initial measurement is more than 0.1 e.

Record the following data:
a) date and time,
b) temperature,
c) barometric pressure,
d) relative humidity,
e) test load,
f indication,
g) errors,
h) changes in test location,
and apply all necessary corrections resulting from variations of temperature, pressure, and other influence factors due to the test load between the various measurements.

Allow full recovery of the EUT before any other tests are performed.

Maximum allowable variations: The variation in the errors of indication shall not exceed half the verification scale interval or half the absolute value of the maximum permissible error on initial verification for the test load applied, whichever is greater, on any of the n measurements.

Where the differences of the results indicate a trend more than half the allowable variation specified above, the test shall be continued until the trend comes to rest or reverses itself, or until the error exceeds the maximum allowable variation.

ANNEX C
(mandatory for separately tested modules)

TESTING AND CERTIFICATION OF INDICATORS AND ANALOG DATA PROCESSING DEVICES AS MODULES OF NON-AUTOMATIC WEIGHING INSTRUMENTS

C.1 Applicable requirements

These requirements are a supplement to the requirements of chapter 4 applicable to weighing instruments as well as to indicators (e.g. design of the display, format of weighing results; sensitivity to influence factors and disturbances). When the term “indicator” is used, the following requirements mean “analog data processing device” as well.

The following requirements for a semi-self or a self-indicating weighing instrument also apply to indicators:

3.1.1 Accuracy classes
3.1.2 Minimum value of the verification scale interval
3.2 Classification of instruments
3.3 Additional requirements for a multi-interval and a multiple range instrument
3.4 Auxiliary indicating devices
3.5 Maximum permissible errors
3.9.2 Temperature
3.9.3 Mains power suply
3.10 Type evaluation tests and examinations
4.1 General requirements
4.1.1 Suitability
4.1.2 Security
4.2 Indication of weighing results
4.3 Analogue indicating device
4.4 Digital indicating device
4.5 Zero-setting and zero-tracking devices
4.6 Tare device
4.7 Preset-tare device
4.9 Auxiliary verification devices
4.10 Selection of weighing ranges on a multiple range instrument
4.11 Devices for selection (or switching) between various load receptors - load transmitting devices and various load measuring devices in use.
4.12 Plus and minus comparator instrument
4.13 Instrument for direct sales to public
4.14 Additional requirements for an instrument for direct sales to the public with price indication
4.16 Price-labelling instrument

Additonal requirements for electronic instruments:

5.1 General requirements
5.2 Acting upon significant faults
5.3 Functional requirements

5.4 Performance and span stability test
5.5 Additional requirements for software-controlled electronic devices

C.1.1 Accuracy class

The indicator shall have the same accuracy class as the weighing instrument it is intended to be used with.

C.1.2 Number of verification scale intervals

The indicator shall have the same or a higher number of verification scale intervals than the weighing instrument it is intended to be used with.

C.1.3 Temperature range

The indicator shall have the same or a larger temperature range than the weighing instrument it is intended to be used with.

C.1.4 Range of input signal

The range of the input signal the indicator is specified for shall be within the range of the analogue output signal of the load cell(s) connected.

C.1.5 Minimum input signal per verification scale interval

The minimum input signal per verification scale interval (μV) the indicator is specified for shall be equal or smaller than the analogue output signal of the load cell(s) connected divided by the number of scale intervals of the weighing instrument.

C.1.6 Range of load cell impedance

The resulting impedance of the load cell(s) connected to the indicator shall be within the range the indicator is specified for.

C.1.7 Maximum cable length

Indicators employing six wire technology with remote sensing (of the load cell excitation voltage) shall be used, when the load cell cable has to be lengthened or several load cells are connected by means of a separate load cell junction box. However, the length of the (additional) cable between the load cell or the load cell junction box and the indicator shall not exceed the maximum length the indicator is specified for. The maximum cable length depends on the material and the cross section of the single wire, and thus can also be expressed as the maximum wire resistance, given in units of impedance.

C.2 General principles of testing

To limit the number of tests the indicator should, as far as possible, be tested under conditions which cover the maximum range of applications. This means that most tests shall be performed under worst case conditions. A number of tests can be performed with either a load cell or a simulator but both have to fulfil the requirements of A.4.1.7 of R76-1. However the disturbance tests should be performed with a load cell or a load receptor being the most realistic case.

C.2.1 Worst case conditions

In order to limit the number of tests, the indicator shall be tested under conditions which cover the maximum range of applications. This means that most tests shall be performed under worst case conditions.

C.2.1.1 Minimum input signal per verification scale interval e

The indicator shall be tested at minimum input signal (normally minimum input voltage) per (verification scale interval) e specified by the manufacturer. This is assumed to be the worst case for the performance tests (intrinsic noise covering the load cell output signal) and for the disturbance tests (unfavourable ratio of signal and e.g. high frequency voltage level) as well.

C.2.1.2 Minimum simulated dead load

The simulated dead load shall be the minimum value the manufacturer has specified. A low input signal of the indicator covers the maximum range of problems with regard to linearity and other significant properties. The possibility of a larger zero drift with a larger dead load is regarded as a less significant problem. However, possible problems with the maximum value of the dead load (e.g. saturation of the input amplifier) have to be considered.

C.2.2 Testing at high or low simulated load cell impedance

The disturbance tests (see 5.4.3 of R76-1) shall be performed with a load cell instead of a simulator and with the highest practical value of the impedance (at least $^{1}/_{3}$ of the specified highest impedance) for the load cell(s) to be connected as specified by the manufacturer. For the “Immunity to radiated electromagnetic fields” test the load cell(s) should be placed within the uniform area (IEC 61000-4-3) inside the anechoic chamber. Load cell cable shall not be decoupled because the load cell is supposed to be an essential part of the weighing instrument and not a peripheral (see also figure 6 in IEC 61000-4-3 which shows a test set-up of a modular EUT).

The influence tests (see 5.4.3 of R76-1) may either be performed using a load cell or a simulator. However the load cell / simulator shall not be exposed to the influence during the tests (i.e. simulator is outside the climate chamber). The influence tests shall be performed at the lowest impedance of the load cell(s) to be connected as specified by the applicant.

The following table 12 indicates which test has to be performed with the lowest impedance (low) and which one with the highest practical value of the impedance (high).

Table 12

Article No. R76-1	*Article concerning*	*Fraction p_i*	*Impedance*	*µV / e*
A.4.4	*Weighing performance*	*0.3 .. 0.8*	*low*	*min*
A.4.5	*Multiple indicating device*			
	Analogue	*1*	*low*	*min*
	Digital	*0*	*low*	*min*
A.4.6.1	*Weighing accuracy with tare*		*low*	*min*
A.4.10	*Repeatability*		*low*	*min/max ***
A.5.2	*Warm-up time test*	*0.3 .. 0.8*	*low*	*min/max ***
A.5.3.1	*Temperature (effect on amplification)*	*0.3 .. 0.8*	*low*	*min/max ***
A.5.3.2	*Temperature (effect on no load)*	*0.3 .. 0.8*	*low*	*min*
A.5.4	*Power voltage variation*	*1*	*low*	*min*
3.9.5	*Other influences*			
B.2.2	*Damp heat steady state*	*0.3 .. 0.8*	*low*	*min/max ***
B.3.1	*Short time power reduction*	*1*	*high**	*min*
B.3.2	*Bursts*	*1*	*high**	*min*
B.3.3	*Electrostatic discharge*	*1*	*high**	*min*
B.3.4	*Electromagnetic susceptibility*	*1*	*high**	*min*
B.4	*Span stability*	*1*	*low*	*min*

* Test has to be performed with load cell.
** See C.3.2.1

The impedance of the load cell referred to in this annex is the input impedance of the load cell which is the impedance that is connected between the excitation lines.

C.2.3 Peripheral equipment

Peripheral equipment shall be supplied by the applicant to demonstrate correct functioning of the system or sub-system and the non-corruption of weighing results.

When performing disturbance tests, peripheral equipment may be connected to all different interfaces. However, if not all optional peripheral equipment is available or can not be placed on the test site (especially when having to place them in the uniform area during radiated fields tests), then at least cables shall to be connected to the interfaces. Cable types and lengths shall be as specified in the manufacturer's authorized manual. If cable lengths longer than 3 metres are specified, testing with lengths of 3 metres is regarded as being sufficient.

C.2.4 Adjustment and performance tests

The adjustment (calibration) has to be performed as described by the manufacturer. Weighing tests shall be performed with at least five different (simulated) loads reaching from zero to the maximum number of verification scale intervals (e) with the minimum input voltage per e (for high sensitive indicators possibly also with the maximum input voltage per e, see C.2.1.1). It is preferable to choose points close to the changeover points of the error limits.

C.2.5 Indication with a scale interval smaller than e

If an indicator has a device for displaying the weight value with a smaller scale interval (not greater than 1/5 x pi x e, high resolution mode), this device may used to determine the error. It may also be tested in service mode where the AD-counts are given. If either device is used it should be noted in the Evaluation Report.

Prior to the tests it shall be verified that this indicating mode is suitable for establishing the measuring errors. If the high resolution mode does not fulfil this demand, a load cell, weights and small additional weights shall be used to determine the change-over points with an uncertainty better than (1/5) x pi x e. (see A.4.4.4 of R76-1).

C.2.6 Load cell simulator

The simulator shall be suitable for the indicator. The simulator shall be calibrated for the used excitation voltage of the indicator (AC excitation voltage means also AC calibration).

C.2.7 Fractions p_i

The standard fraction is $p_i = 0.5$ of the maximum permissible error of the complete instrument, however, it may vary between 0.3 and 0.8.

The manufacturer has to fix the fraction pi which than is used as a basis for the tests for which a range of pi is assigned to (see table under C.2.2).

No value for the fraction pi is given with respect to repeatability. Insufficient repeatability is a typical problem of mechanical instruments with leverworks, knives and pans and other mechanical structure that may cause e.g. a certain friction. It is expected that the indicator will normally not cause a lack in repeatability. In the rare cases it does, this is not a lack of repeatability within the meaning of R76-1, however, special attention shall be paid to the reasons and the consequences.

C.3. Tests

The relevant parts of the test report (see C.1) and checklist of OIML R76-2 shall be used for an indicator. The non-relevant parts of the OIML R76-2 checklist are (requirements):

7.1.5.1
3.9.1.1
4.12.1
4.12.2
4.12.3
4.18.1
4.18.2

4.14.10

C.3.1 Temperature and performance tests

In principle, the temperature effect on the amplification is tested according to the following procedure:

- Carry out the prescribed adjustment procedure at 20 °C;

- Change the temperature and verify that the measuring points are within the error limits after correction of a zero shift.

This procedure shall to be carried out at the highest amplification and the lowest impedance to which the indicator can be adjusted. However, those conditions shall ensure that the measurement can be performed with such an accuracy that it is sufficiently certain that non-linearities found in the error curve are not caused by the test equipment used.

In case this accuracy cannot be reached (e.g. with high sensitive indicators) the procedure has to be carried out twice (C.2.1.1). The first measurement has to be carried out with the lowest amplification, using at least 5 measuring points. The second measurement is carried out with the highest amplification, using two measuring points, one at the low end and one at the high end of the measuring range. The change in amplification due to temperature is acceptable if a line of the same form found at the first measurement, drawn between the two points and corrected for a zero-shift, is inside the relevant error limits (error envelope).

The temperature effect on no load indication is the influence of temperature variation on the zero expressed in changes of the input signal in µV. The zero drift is calculated with the help of a straight line through the indications at two adjacent temperatures. The zero drift should be less than pi x e / 5K

C.3.1.1 Tests with high and low amplification

If the minimum input voltage per verification scale interval is very low, i.e. less than or equal to 1 µV/e, it may be difficult to find a suitable simulator or load cell to determine the linearity. If the value of the fraction pi is 0.5 for an indicator with 1 µV/e then the maximum permissible error for simulated loads smaller than 500 e is 0.25 µV/e. The error of the simulator shall not cause effect exceeding 0.05 µV/e or at least the repeatability should be equal or better than 0.05 µV/e.

(a) The linearity of the indicator is tested over the complete input range. **Example:** A typical indicator with a load cell excitation power supply of 12 V has a measuring range of 24 mV. If the indicator is specified for 6000 e the linearity can be tested with 24 mV/6000 e = 4 µV/e.

(b) With the same set-up the temperature effect on the amplification shall be measured, during the static temperature test and during the damp heat steady state test.

(c) After that the indicator is set up with the minimum dead load specified and with the minimum input voltage per verification scale interval e. Suppose this value is 1 μV/e, which means that only 25% of the input range is used.

(d) The indicator shall now be tested with an input voltage close to 0 mV and close to 6 mV. The indication at both input voltages is registered at 20, 40, -10, 5 and 20 °C. The difference between the indication at 6 mV (corrected for the indication at 0 mV) at 20 °C and the corrected indications at the other temperatures are introduced in a graph. The points found are connected to the zero point by means of curves of the same shape form as those found (a) and (b). The curves drawn shall be within the error-envelope for 6000 e.

(e) During this test the temperature-effect on no load indication can also be measured to see if the effect is less than p_i × 1e/5 K.

(f) If the indicator fulfils the above-mentioned requirements it also complies with 3.9.2.1, 3.9.2.2, 3.9.2.3 of R76-1 and it complies with the requirements for the static temperature test and damp heat steady state test.

C.3.2 Tare

The influence of tare on the weighing performance depends exclusively on the linearity of the error curve. The linearity will be determined when the normal weighing performance tests are carried out. If the error curve shows a significant nonlinearity, the error envelope shall be shifted along the curve, to see if the indicator meets the demands for the tare value corresponding with the steepest part of the error curve.

C.3.3 Testing the sense function (with six wire load cell connection only)

C.3.3.1 Scope

Indicators intended for connection of strain gauge load cells employ the 4-wire or the 6-wire principle of the load cell connection. When 4-wire technology is used lengthening cable the load cell cable or using a separate load cell junction box with an extra cable is not allowed at all. Indicators using 6-wire technology have a sense input enabling the indicator to compensate variations in load cell excitation voltage due to lengthened cables or changes of cable resistance due to temperature. However, in contrast to the theoretical principle of function, the compensation of variations in load cell excitation voltage is limited due to a limited input resistance of the sense input. This may lead to an influence by variation of cable resistance due to temperature variation and result in a significant shift of the span.

C.3.3.2 Test

The sense function shall be tested under worst case conditions, that is the maximum charge of the load cell excitation (simulating the maximum number of load cells that may be connected) and the maximum cable length shall be simulated.

C.3.3.2.1 Simulated maximum number of load cells

The maximum number of load cells can be simulated by putting an extra ohmic shunt resistor on the excitation lines, connected in parallel to the load cell simulator or the load cell respectively.

C.3.3.2.2 Simulated maximum cable length

The maximum cable length can be simulated by putting variable ohmic resistors in all six lines. The resistors shall be set to the maximum cable resistance and thus the maximum cable length (depending on the intended material, e.g. copper or others, and the cross section). However, in most cases it is sufficient to place the resistors only in the excitation lines and the sense lines, since the input impedance of the signal input is extremely high in comparison to that of the sense input. Therefore the signal input current is nearly zero or at least extremely small in comparison to the current on the excitation and sense lines. The input current being near to zero no significant effect can be expected, since the voltage drop is neglectable.

C.3.3.2.3 Readjustment of the indicator

The indicator shall be readjusted after having placed the cable simulation resistors.

C.3.3.2.4 Determining the span variation

The span between zero and maximum (simulated) load shall be measured. It is assumed that under worst case conditions a change of resistance due to a temperature change corresponding to the whole temperature range of the instrument may occur. Therefore a variation of the resistance ΔR_{Temp} corresponding to the difference between minimum and maximum operating temperature shall be simulated. The expected variation of resistance shall be determined according to the following formula:

$$\Delta R_{Temp} = R_{cable} \text{ x } \alpha \text{ x } (T_{max} - T_{min})$$

R_{cable}: resistance of a single wire, calculated according to the following formula:

$$R_{cable} = (\rho \text{ x } l) \text{ } A$$

ρ: specific resistance of the material (e.g. copper: $\rho_{copper} = 0{,}0175\ \Omega\ mm^2 / m$)
l: length of the cable (in m)
A: cross section of the singe wire (in mm^2)

α: temperature coefficient of the cable material in 1/K

After having set the variable ohmic resistors to the new value the span between zero and maximum load shall be determined again. Since the variation can be positive or negative both directions shall be tested, e.g. for a class III instrument the variation of simulated cable resistance shall correspond to a variation of temperature by plus or minus 50 K (temperature range being –10 °C to +40 °C).

C.3.3.2.5 Limits of span variation

For determining the limits of span variation due to temperature influence on the cable, the results of the temperature tests on the indicator shall be considered. The difference between the maximum span error of the indicator due to temperature and the error limit may be assigned to the effect on the span due to limited compensation by the sense device. However, this effect shall not cause an error of more than one third of the absolute value of the maximum permissible error multiplied by p_i.

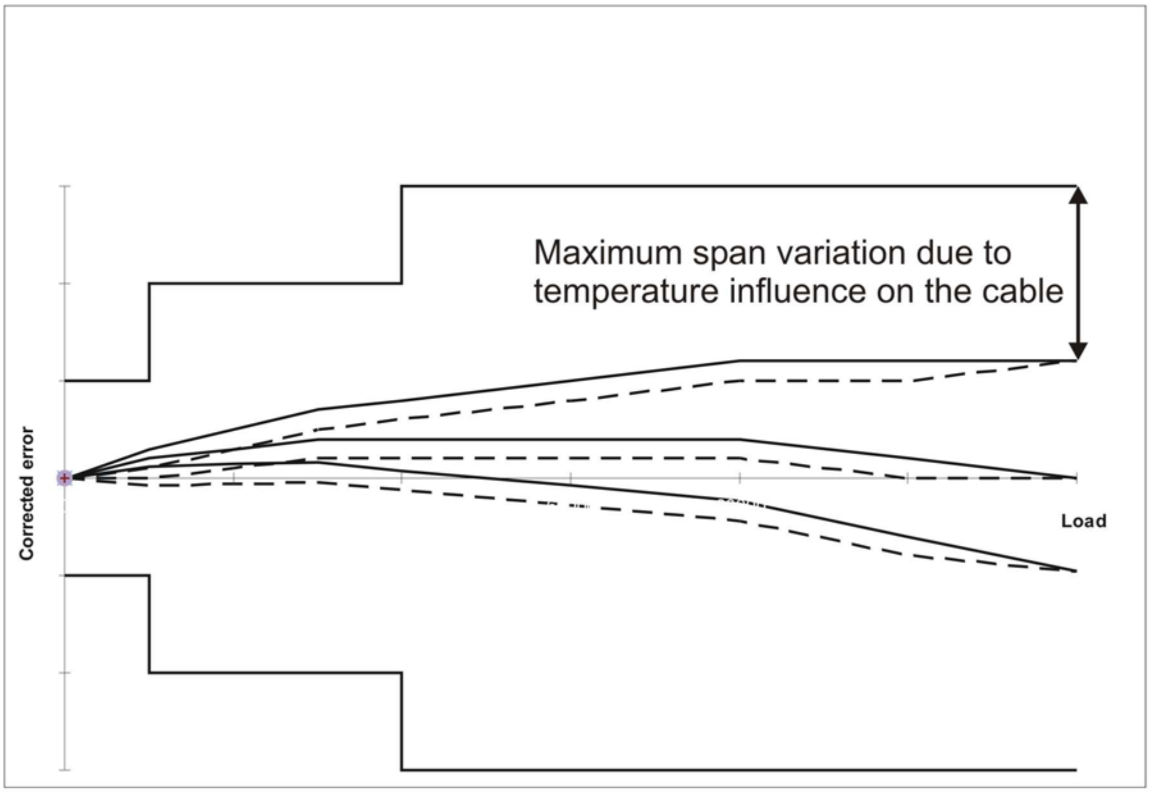
$\Delta span(\Delta T) \leq p_i \times mpe - E_{max}(\Delta T)$

while

$\Delta span(\Delta T) \leq {}^{1}/_{3}\, p_i \times mpe_{abs}$

If the indicator is not able to meet these conditions, the maximum cable resistance and thus the maximum cable length has to be reduced or a larger cross section has to be chosen.

The specific cable length may be given in the shape of m/mm^2 (depending on the material of the cable, e.g. copper, aluminium).



C.3.4 Other influences

Other influences and restraints should be taken into consideration for the complete instrument and not for the modules.

C.4 OIML certificates

C.4.1 General

For the lay-out the general rules of OIML-P1 Annex A shall be observed as far as applicable.

C.4.1.1 Description of the shape of the indicator

The shape that is the housing, display, keyboard, plugs and connectors etc. shall be shortly described supported by corresponding figures or photos of the indicator.

C.4.1.2 Description of functions

Functions and facilities such as zero setting devices, tare devices etc.(see chapter 4), and facilities of electronic instruments as mentioned in chapter 5 shall be listed.

C.4.1.3 Description of descriptive markings

The means to apply the descriptive markings shall be described considering 7.1.4 and 7.1.5 as far as applicable. In addition to the complete instrument the module itself must be clearly identifiable.

C.4.1.4 Description of provisions for verification marks and for sealing / securing

The places for the descriptive plate and the verification marks shall be described. If applicable the means for sealing and securing the indicator shall be described and shown in figures or photos.

C.4.2 Technical data

In order to check the compatibility of modules when using the modular approach (see 3.10.2 and Annex E) a certain set of data is necessary. This part contains the data of the indicator in the same presentation and units that is needed to check the requirements of Annex E easily.

C.4.2.1 Metrological data with regard to the weighing instrument

- Accuracy class
- Maximum number of verification scale intervals n
- Operating temperature range (°C)
- Value of the fractional error p_i

C.4.2.2 Electrical data

- Power supply voltage (V AC or DC)
- Form (and frequency (Hz)) of the power supply
- Load cell excitation voltage (V AC or DC)
- Minimum signal voltage for dead load (mV)
- Maximum signal voltage for dead load (mV)
- Minimum input-voltage per verification scale interval e (µV)
- Measuring range minimum voltage (mV)
- Measuring range maximum voltage (mV)

- Minimum load cell impedance (Ω)
- Maximum load cell impedance (Ω)

C.4.2.3 Sense system

existing or not existing

C.4.2.4 Signal cable

Additional cable between the indicator and the load cell or the load cell junction box respectively (only allowed with indicators using six wire system, i.e. sense system) shall be specified as follows:

- material (copper, aluminium etc.)
- length (m)
- cross section (mm^2)

or

- specific length (m/mm^2) when the material (copper, aluminium etc.) is fixed

or

- maximum ohmic resistance per single wire

ANNEX D
(mandatory for separately tested modules)

TESTING AND CERTIFICATION OF WEIGHING MODULES AS MODULES OF NON-AUTOMATIC WEIGHING INSTRUMENTS

D.1 Applicable requirements

D.1.1 Requirements for weighing modules

The following requirements for a semi-self or a self-indicating weighing instrument also apply for weighing modules:

- 3.1 Principles of classification
- 3.2. Classification of instruments
- 3.3 Additional requirements for a multi-interval instrument
- 3.5 Maximum permissible errors
- 3.6 Permissible differences between results
- 3.8 Discrimination
- 3.9 Variations due to influence and time
- 3.10 Type evaluation tests and examinations
- 4.1 General requirements of construction
- 4.2 Indication of weighing results
- 4.4 Digital indicating device
- 4.5 Zero-setting and zero-tracking devices
- 4.6 Tare device
- 4.7 Preset-tare device
- 4.10 Selection of weighing ranges on a multiple range instrument
- 4.11 Devices for selection (or switching) between various load receptors - load transmitting devices and various load measuring devices
- 4.13 Instrument for direct sales to public
- 4.14 Additional requirements for an instrument for direct sales to the public with price indication
- 4.16 Price-labelling instruments
- 5.1 General requirements
- 5.2 Acting upon significant faults
- 5.3 Functional requirements
- 5.4 Performance and span stability test
- 5.5 Additional requirements for software-controlled electronic devices

D.1.2 Supplement requirements

D.1.2.1 Fraction of error limits

For a weighing module, the fraction is p_i = 1.0 of the maximum permissible error of the complete instrument.

D.1.2.2 Accuracy class

The weighing module shall have the same accuracy class as the weighing instrument it is intended to be used with. A weighing module of class III can also be used in a weighing instrument of class IIII taking into account the requirements of class IIII.

D.1.2.3 Number of verification scale intervals

The weighing module shall have the same or a higher number of verification scale intervals than the weighing instrument it is intended to be used with.

D.1.2.4 Temperature range

The weighing module shall have the same or a larger temperature range than the weighing instrument it is intended to be used with.

D.2 General principles of testing

D.2.1 General

A weighing module shall be tested in the same way as a complete weighing instrument, with the exception of testing the design and construction of the indicating device and control elements.
However, all indicated values and all functions which are transmitted and/or released via the interface shall be tested if they are correctly and in compliance with this Recommendation.

D.2.2 Indicating device

For this test a suitable indicating device or terminal shall be connected to indicate the respective weighing results and to operate all functions of the weighing module.
If the weighing results of the weighing module have a differentiated scale division acc. 3.4.1 the indicating device shall indicate this digit.
An any case the indicating device should allow to indicate a higher resolution to determine the error, e.g. in a special service mode. If a higher resolution is used it should be noted in the Evaluation Report.

D.2.3 Interface

For all interfaces the requirements of 5.3.6 are applicable.

D.2.4 Peripheral equipment

Peripheral equipment shall be supplied by the applicant to demonstrate correct functioning of the system or sub-system and the non-corruption of weighing results.

When performing disturbance tests peripheral equipment shall be connected to all different interfaces.

D.3 Tests

The complete testing procedure for non-automatic weighing instruments acc. ANNEX A and ANNEX B shall be performed.

The test report and the checklist of OIML R76-2 shall be used also for weighing modules.

The parts of the checklist of OIML R76-2 related to "descriptive markings", "verification marks and sealing" and partially to "indicating device" are not relevant and must not be filled in.

D.4 OIML Certificates

D.4.1 General

The certificate shall contain common information and data about the issuing authority, the manufacturer and the weighing module. For the lay-out the general rules of OIML-P1 Annex A shall be observed as far as applicable.

D.4.2 Test report

The R76-2 test report shall contain detailed information about the weighing module. These are technical data, description of the functions, characteristics, features and the checklist of R76-2. In the following all relevant information is listed:

Report No.:	zzzzz
Type Examination of a	Weighing module for a non-automatic electromechanical weighing instrument
Issuing authority:	name, address, person responsible
Manufacturer:	name, address
Type of module :	....
Test requirements:	R 76-1, edition 200x
Summary of the examination:	Separately tested module, p_i = 1,0, connected device for indicating the weighing results and to operate the module, connected peripherals, special informations as if some tests were performed by the manufacturer and why they were accepted, results of the test in brief.
Evaluator:	name, date, signature
Table of contents:	

This report belongs to the OIML Certificate N^{o} R76/200x-xx-yyyy

1 General information concerning the type of module :

Description of mechanical structures, load cell, analog data processing device, interfaces.

2 Functions, facilities and devices of the weighing instrument:

Zero-setting devices, tare devices, multi-interval weighing module, different weighing ranges, modes of operation, etc.

3	**Technical data:**	Table with accuracy class, p_i = 1,0, Max, Min, n = , n_i = , tare- and temperature ranges, etc.
4	**Documents:**	List of documents
5	**Interfaces:**	Interface types and numbers for the indicating and operating device (terminal), for peripheral devices and for other devices. All interfaces are protective in the sense of R 76-1, No. 5.3.6.1.
6	**Connectable devices:**	indicating and operating device (terminal) with p_i = 0,0, printer, display, etc. For applications not subject to mandatory verification, any peripheral devices may be connected. Examples: D/A converters, PC or the like.
7	**Control marks:**	If securing (sealing) is required for the weighing instrument, components and adjustment elements of this module can be protected by a control mark (adhesive mark or seal) over the housing srew under the plate of the load receptor. An additional securing is not necessary.
8	**Test equipment:**	Information concerning the test equipment used for type evaluation of this module. Information about calibration. Examples: standard weights (class), load cell simulator, temperature chambers, voltmeters, transformers, disturbance test equipment, etc.
9	**Remarks to the tests:**	In the R76-2 checklist the parts related to the indicator (descriptive markings, verification marks and sealing and partially to indicating device) are not filled in. During the disturbance tests a printer of the type ... was connected.
10	**Measuring results:**	Forms of OIML R76-2
11	**Technical requirements:**	Checklist of OIML R76-2

ANNEX E
(mandatory for separately tested modules)

COMPATIBILITY CHECKING OF MODULES OF NON-AUTOMATIC WEIGHING INSTRUMENTS

E1 to E4: Only for analogue load cells in conformity to OIML R60 in combination with indicators in conformity to OIML R76 Annex C)

E5: Only for Modules with digital output in combination with terminals.

When using the modular approach the check of the compatibility of the weighing instrument and the modules need certain sets of data. This part describes in the first three chapters the data of the weighing instrument, the load cell(s) and the indicator that are needed to check the requirements of compatibility.

E.1 Weighing instrument

Following metrological and technical data of the weighing instrument are necessary for the check of compatibility:

Accuracy class of the weighing instrument

Max	(g,kg,t)	Maximum capacity of weighing instrument according to T.3.1.1
		(Max_1, Max_2, Max) (in case of multi-interval or multiple range weighing instrument)
e	(g, kg)	Verification scale interval according to T.3.2.3
		(e_1, e_2, e_3) (in case of multi-interval or multiple range weighing instrument, where $e_1 = e_{min}$)
n		Number of verification scale intervals according to T.3.2.5 $n = Max / e$
		(n_1, n_2, n_3) (in case of multi-interval or multiple range weighing instrument $n_i = Max_i / e_i$)
R		Reduction ratio, eg of a lever work according to T.3.3, it is the ratio (Force onto the load cell) / (Force onto the load receptor).
N		Number of load cells
ISZR	(g, kg)	Initial zero setting range, according to T.2.7.2.4, it means the indication automatically is set to zero when the weighing instrument is switched on, before any weighing.
NUD	(g, kg)	Correction for non uniform distributed load **.
DL	(g, kg)	Dead load of load receptor, weight of the load receptor himself resting upon the load cells and additionally fix mounted constructions on the load receptor.
T^+		Additive Tare
T_{min}	(°C)	Lower limit of temperature range
T_{max}	(°C)	Upper limit of temperature range

Connecting system, 6-wire-system ?

L	(m)	Length of connecting cable
A	(mm²)	Cross section of wire
Q		Correction factor

The correction factor $Q > 1$ considers the possible effects of eccentric loading (non uniform distribution of the load), dead load of the load receptor, initial zero setting range and additive tare in the following form:

$$Q = (Max + DL + ISZR + NUD + T^{+}) / Max$$

***Note:*

The values for the non uniform distribution of the load generally might be assumed for typical constructions of weighing instruments when no other estimations are presented.

- Weighing instruments (WIs) with lever work and one LC, or
  WIs with load receptors which allow only minimal eccentric load application, or
  WIs with one single point LC, 0% of *Max*

  eg hopper or funnel hopper with a symmetric arrangement of the load cells, but without shaker for material flow on the load receptor
- other conventional WIs: 20% of *Max*
- Fork lift scales, over head track scales and weighbridges 50% of *Max*
- Multi-platform weighing machine
  - fix combined 50% of Max_{total}
  - variable selection or combined 50% of $Max_{single\ bridge}$

E.2 Separately tested load cells

Load cells that have been tested separately according to the International Recommendation OIML R60 may be used without repeated testing if a respective OIML certificate exists and the requirements in 3.10.2.1, 3.10.2.2, and 3.10.2.3 are met.

E.2.1 Accuracy classes

The accuracy classes including temperature ranges and the evaluation of stability against humidity and creep of load cell(s) (LC) must meet the requirements for the weighing instrument (WI).

Table 13: Corresponding accuracy classes

	Accuracy				Reference
WI	I	II	III	IIII	OIML R76
LC	A	A*), B	B*), C	C, D	OIML R60

*) if the temperature ranges are sufficiently and the evaluation of stability against humidity and creep correspond to the requirement in the lower class.

E.2.2 Fraction of the maximum permissible error

If no value for the load cell is indicated in the Certificate of Conformity, then $p_{LC} = 0{,}7$. According to No 3.10.2.1 the fraction may be $0{,}3 \le p_{LC} \le 0{,}8$.

E.2.3 Temperature limits

If no value for the load cell is indicated in the Test Certificate, then T_{min} = -10°C and T_{max} = 40°C. According to No 3.9.2.2 the temperature range may be limited.

E.2.4 Maximum capacity of the load cell

The maximum capacity of the load cell shall satisfy the condition:

$$E_{max} \geq Q \bullet Max \bullet R / N$$

E.2.5 Minimum dead load of the load cell

The minimum load caused by the load receptor must be equal or exceed the minimum dead load of a load cell (A lot of load cells have E_{min} = 0) :

$$E_{min} \leq DL \bullet R / N$$

E.2.6 Maximum number of load cell intervals

For each load cell the maximum number of load cell intervals n_{LC} (see OIML R 60) shall not be less than the number of verification scale intervals n of the instrument:

$$n_{LC} \geq n$$

On a multiple range or multi-interval instrument, this applies to any individual weighing range or partial weighing range:

$$n_{LC} \geq n_i$$

On a **multi-interval** instrument, the minimum dead load output return *DR* (see OIML R 60) shall satisfy the condition:

$$DR \bullet E / E_{max} \leq 0{,}5 \bullet e_1 \bullet R / N \quad \text{resp.} \quad DR / E_{max} \leq 0{,}5 \bullet e_1 / Max$$

where $E = Max \bullet R / N$ is the partial loading of the load cell when loading the weighing instrument with *Max*.

Acceptable solution

Where *DR* is not known, the condition $n_{LC} \geq Max / e_1$ should be satisfied.

Furthermore on a **multiple range** instrument where the same load cell(s) is (are) used for more than one range, the minimum dead load output return *DR* of the load cell (see OIML R 60) shall satisfy the condition

$$DR \bullet E / E_{max} \leq e_1 \bullet R / N \quad \text{resp.} \quad DR / E_{max} \leq e_1 / Max$$

Acceptable solution

Where *DR* is not known, the condition $n_{LC} \geq 0.4 \bullet\cdot Max_{r} / e_1$ should be satisfied.

E.2.7 Minimum load cell verification interval

The minimum load verification interval v_{min} (see OIML R 60) shall not be greater than the verification scale interval e multiplied by the reduction ratio R of the load transmitting device and divided by the square root of the number N of load cells, as applicable:

$$v_{min} \leq e_1 \bullet\cdot R / \sqrt{N}$$

Note: v_{min} is measured in mass units. The formula applies to both analog and digital load cells.

On a multiple range instrument where the same load cell(s) is (are) used for more than one range, or a multi-interval instrument, e is to be replaced by e_1.

Electrical data with regard to the weighing instrument

E.2.8 Input resistance of a load cell

The input resistance of a load cell R_{LC} is limited by the indicator

R_{LC} / N has to meet the range of the indicator $R_{L\ min}$ to $R_{L\ max}$

E.2.9 Rated output of a load cell

Change of output signal of the load cell related to input voltage after loading with E_{max}, normally in mV/V

Note:

For a more moderate calculation the following relative values are introduced in OIML R60

$$Y = E_{max} / v_{min}$$
$$Z = E_{max} / (2*DR)$$

E.3 Separately tested indicators and analogue data processing devices

Indicators and analogue data processing devices that have been tested separately according to Annex C may be used without repeated testing if a respective OIML certificate exists and the requirements in 3.10.2.1, 3.10.2.2, and 3.10.2.3 are met.

E.3.1 Accuracy class

The accuracy classes including temperature ranges and the evaluation of stability against humidity must meet the requirements for the weighing instrument (WI).

Table 14: Corresponding accuracy classes

	Accuracy				Reference
WI	I	II	III	IIII	OIML R76
IND	I	I *) II	II *) III	III IIII	OIML R76

*) if the temperature ranges are sufficiently and the evaluation of stability against humidity correspond to the requirement in the lower class.

E.3.2 Fraction of the maximum permissible error

If no value for the indicator is indicated in the Certificate of Conformity, then $p_{ind} = 0,5$. According to No 3.10.2.1 the fraction may be $0,3 \leq p_{ind} \leq 0,8$.

E.3.3 Temperature limits

If no value for the load cell is indicated in the Test Certificate, then T_{min} = -10°C and T_{max} = 40°C. According to No 3.9.2.2 the temperature range may be limited.

E.3.4 Maximum number of verification intervals

For each indicator the maximum number of verification intervals n_{ind} shall not be less than the number of verification scale intervals n of the weighing instrument:

$$n_{ind} \geq n$$

On a multiple range or multi-interval instrument, this applies to any individual weighing range or partial weighing range:

$$n_{ind} \geq n_i$$

In case of **multi-interval** or **multiple range** application these functions must be included in the certified indicator.

E.3.5 Electrical data with regard to the weighing instrument

U_{exc}	(V)	Load cell excitation voltage
U_{min}	(mV)	General minimum input voltage for indicator
Δu_{min}	(µV)	Minimum input voltage per verification scale interval for the indicator The signal per verification scale interval Δu is calculated as follows: $\Delta u = \frac{C}{E_{max}} \cdot U_{exc} \cdot \frac{R}{N} \cdot e$ for multiple range or multi-interval WIs $e = e_1$
	(mV)	Measuring range minimum voltage
	(mV)	Measuring range maximum voltage
R_{Lmin},	(Ω)	Minimum load cell impedance
R_{Lmax}	(Ω)	Maximum load cell impedance Limits of allowed impedance range for the electronic indicator for the actual applied load cell input impedance(s).

E.3.5.1 Connection cable

Additional cable between the indicator and the load cell or the load cell junction box respectively (only allowed with indicators using six wire system, i.e. **sense system**) must have been specified in the Certificate of Conformity for the indicator.
The most simple procedure is to specify in the indicator certificate a value for the ratio cable length to cross section of one wire (m/mm²) for a given material (copper, aluminium etc.)
In other cases it must be calculated out of length (m), cross section (mm²), the conductor material data and the maximum ohmic resistance (Ω) per single wire.

Note:

For cable with different cross sections of the wires the connection for sense-wire is of interest.

When using lightning barriers or barriers for explosion-proof application, the excitation voltage at the load cells must be checked, to prove condition for minimum input voltage per verification scale interval of the indicator.

E.4 Compatibility checks for modules with analogue output

The relevant quantities and characteristics identified which together establish the compatibility have been included on the following form. These form cover the complete instrument, the electronic indicator and the load cell(s), plus 4 conditions referred to in R76 and another 6 conditions which are for technical reasons as a result of the section itself. The tables, where the data shall be entered allow for an easy decision to be taken as to whether or not they are satisfied.

The manufacturer of the weighing instrument can check and prove this compatibility by filling in the form given in the following page.

Form: Check of Compatibility

(1) Accuracy class of load cell (LC), indicator (IND) and weighing instrument (WI)

LC	&	IND	equal or better	WI	passed	failed
	&		equal or better		☐	☐

2) Temp.limits of the weighing instr.(WI) compared with the temp.limits of the load cell (LC) and the indicator (IND) in °C

	LC		IND		WI	passed	failed
T_{min}		&		≤		☐	☐
T_{max}		&		≥		☐	☐

(3) Sum of the squares of the fractions p_i of the max. permissible errors of connecting elements, indicator and load cells

p_{con}^2	+	p_{ind}^2	+	p_{LC}^2	≤ 1	passed	failed
	+		+		≤ 1	☐	☐

(4) Maximum number of verification scale intervals of the indicator and number of scale intervals of the weighing

		n_{ind}	≥	$n_{(i)} = Max_{(i)} / e_{(i)}$	passed	failed
One range weighing instrument			≥		☐	☐
Multi-interval or multiple range WI	i = 1		≥		☐	☐
	i = 2		≥		☐	☐
	i = 3		≥		☐	☐

(5) Maximum capacity of load cells must be compatible to Max of the weighing instrument

Factor Q : $Q = (Max_r + DL + IZSR + NUD + T^+)/Max_r =$ .....

$Q*Max*R/N$	≤	E_{max}	passed	failed
	≤		☐	☐

(6a) Maximum number of verification scale intervals of the load cell and number of scale intervals of the weighing

		n_{LC}	≥	$n_{(i)} = Max_{(i)} / e_{(i)}$	passed	failed
One range weighing instrument			≥		☐	☐
Multi-interval or multiple range WI	i = 1		≥		☐	☐
	i = 2		≥		☐	☐
	i = 3		≥		☐	☐

(6b) Minimum dead load output return of the load cell and smallest verification scale interval e_1 of a multi-interval WI

n_{LC} or $Z = E_{max} / (2*DR)$	≥	Max_r / e_1	passed	failed
	≥		☐	☐

(6c) Minimum dead load output return of the load cell and smallest verification scale interval e1 of a multiple range WI

n_{LC} or $Z = E_{max} / (2*DR)$	≥	$0{,}4*Max_r/e_1$	passed	failed
	≥		☐	☐

(6d) Actual dead load of the load receptor to the minimum dead load of the load cells in kg

	≥	E_{min}	passed	failed
	≥		☐	☐

(7) Verification scale interval of the weighing instrument and minimum load cell scale interval (in kg) must be compatible

$e*R/\sqrt{N}$	≥	$v_{min} = E_{max} / Y$	passed	failed

		≧		☐	☐

(8) Minimum input voltage in general for the electronic indicator and minimum input voltage per verification scale interval and actual output of the load cells

Minimum input voltage in general	$U = C*U_{exc}*R*DL/(E_{max}*N)$	≧	U_{min}	passed	failed
for electr. ind. (unloaded WI)		≧		☐	☐
minimum input voltage per	$\Delta u = C*U_{exc}*R*e/(E_{max}*N)$	≧	Δu_{min}	passed	failed
verification scale interval		≧		☐	☐

(9) Allowed impedance range for the electronic indicator and actual load cell impedance in Ω

R_{Lmin}	≦	R_{LC}/N	≦	R_{Lmax}	passed	failed
	≦		≦		☐	☐

(10) Length of extension cable between the load cell(s) and indicator per wire cross section of this cable in m/mm²

(L/A)	≦	$(L/A)_{max}$	passed	failed
	≦		☐	☐

E.5 Compatibility checks for modules with digital output

For weighing modules and other digital devices no special compatibility checks are necessary; testing of correct functioning of one complete instrument is sufficient. If there is no correct data transmission between the modules, and probably other components/devices the instrument will not work at all or some functions will fail, eg. zero setting or tare.

For digital load cells the same compatibility check as in E.4 applies, with the exception of the conditions No (8), (9) and (10) in the form. The maximum cable length shall be stated in the data sheet of the respective OIML R60 certificate.

ANNEX F
(mandatory for software-controlled digital devices and instruments)

ADDITIONAL EXAMINATIONS AND TESTS FOR SOFTWARE-CONTROLLED DIGITAL DEVICES AND INSTRUMENTS

Preliminary note:
This Annex applies with the proviso that general examination and test procedures for software-controlled devices and measuring instruments will be developed by OIML TC5/SC2.

F.1 Devices and instruments with embedded software (5.5.1)

Review the descriptive documents according to 8.2.1.2 and check whether the manufacturer has described or declared that the software is embedded, ie. that it is used in a fixed hardware and software environment and cannot be modified or uploaded via any interface or by other means after securing or sealing.

Check whether the securing means are described and provide evidence of an intervention.

Check whether there is a software identification that is clearly assigned to the measurement software and the legally relevant functions it performs as described in the documentation submitted by the manufacturer.

Check whether the software identification is easily provided by the instrument.

F.2 Personal computers and other devices with programmable or loadable software (5.5.2)

F.2.1 Software documentation

Check whether there is a special software documentation according to 5.5.2.2 (d) supplied by the manufacturer which contains all relevant information to examine the measurement software.

F.2.2 Software protection

F.2.2.1 Software with closed shell (no access to the operating system and/or programs possible for the user):

- Check whether there is a complete set of commands (e.g. function keys or commands via external interfaces) supplied and accompanied by short descriptions
- Check whether the manufacturer has submitted a written declaration of the completeness of the set of commands

F.2.2.2 Operating system and / or program(s) accessible for the user:

- Check whether a checksum or equivalent signature is generated over the machine code of the measurement software (program module(s) subject to legal control and type-specific parameters)

- Check whether the measurement software cannot be started if the code is falsified using a text editor

F.2.2.3 In addition to the cases F.2.2.1 or F.2.2.2:

- Check whether all device-specific parameters are sufficiently protected, eg. by a checksum
- Check whether there is an audit trail for the protection of the device-specific parameters and a description of the audit trail
- Perform some practical spotchecks to test whether the documented protections and functions work as described

F.2.3 Software interface(s)

- Check whether the program modules of the measurement software are defined and separated from the modules of the associated software by a defined protective software interface
- Check whether the protective software interface itself is part of the measurement software
- Check whether the *functions* of the measurement software that can be released via the protective software interface are defined and described
- Check whether the *parameters* that may be exchanged via the protective software interface are defined and described
- Check whether the description of the functions and parameters are conclusive and complete
- Check whether each documented function and parameter does not contradict to the requirements of this Recommendation
- Check whether there are appropriate instructions for the application programmer (e.g. in the software documentation) concerning the protectiveness of the software interface

F.2.4 Software identification

- Check whether there is an appropriate software identification generated over the program module(s) of the measurement software and the type-specific parameters at runtime of the instrument
- Check whether the software identification is indicated on manual command and can be compared with the reference identification fixed at type approval
- Check whether all relevant program module(s) and type-specific parameters of the measurement software are included in the software identification
- Check also by some practical spotchecks whether the checksums (or other signatures) are generated and work as documented
- Check whether an effective audit trail exists

F.3 Data Storage Devices (5.5.3)

Review the documentation submitted and check whether the manufacturer has foreseen a device - whether incorporated in the instrument or connected externally- that is intended to be used for long-term storage of legally relevant data. If so:

F.3.1 Check whether the software used for data storage is realised on a device with embedded software (F.1) or with programmable/ loadable software (F.2). Apply either F.1 or F.2 to examine the software used for data storage.

F.3.2 Check whether the data are stored and given back correctly.

Check whether the storage capacity and the measures to prevent inadmissible data loss are described by the manufacturer and are sufficient.

F.3.3 Check whether the data stored contain all relevant information necessary to reconstruct an earlier weighing (relevant information is: gross or net values and tare values (if applicable, together with a distinction of tare and preset tare), the decimal signs, the units (eg kg may be encoded), the identification of the data set, the identification number of the instrument or load receptor if several instruments or load receptors are connected to the data storage device, and a checksum or other signature of the data set stored.

F.3.4 Check whether the data stored are adequately protected against accidental or intentional changes.

Check whether the data are protected at least with a parity check during transmission to the storage device.

Check whether the data are protected at least with a parity check in the case of a storage device with embedded software (5.5.1).

Check whether the data are protected by an adequate checksum or signature (at least 2 bytes, eg. a CRC-16 checksum with hidden polynomial) in the case of a storage device with programmable or loadable software (5.5.2).

F.3.5 Check whether the data stored are capable of being identified and displayed, that the identification number(s) is stored for later use and recorded on the official transaction medium, ie. it is printed, for instance, on the print-out.

F.3.6 Check whether the data used for a transaction are stored automatically, ie. not depending on the decision of the operating person.

F.3.7 Check whether stored data sets which are to be verified by means of the identification are displayed or printed on a device subject to legal control.

F.4 Test report

The test report shall contain all relevant information about the hardware and software configuration of the PC examined and the test results.

BIBLIOGRAPHY

	Standard	Description
/1/	IEC Publication 60068-2-1 (1990-05) with amendments 1 (1993-02) and 2 (1994-06) Environmental testing, Part 2: Tests, Test A: Cold	concerns cold tests on both non heat dissipating and heat dissipating specimens
	IEC Publication 60068-2-2 (1974-01) with amendments 1 (1993-02) and 2 (1994-05): Environmental testing Part 2: Tests, Test B: Dry heat	contains test Ba : dry heat for non heat dissipating specimen with sudden change of temperature; test Bb dry heat for non heat dissipating specimen with gradual change of temperature; tests Bc : dry heat for heat dissipating specimen with sudden change of temperature; test Bd dry heat for heat dissipating specimen with gradual change of temperature. The 1987 reprint includes IEC No. 62-2-2A
	IEC 60068-3-1 (1974-01) + Supplement A (1978-01): Environmental testing Part 3 Background information, Section 1: Cold and dry heat tests	Gives background information for Tests A: Cold (IEC 68-2-1), and Tests B: Dry heat (IEC 68-2-2). Includes appendices on the effect of: chamber size on the surface temperature of a specimen when no forced air circulation is used; airflow on chamber conditions. and on surface temperatures of test specimens; wire termination dimensions and material on surface temperature of a component; measurements of temperature, air velocity and emission coefficient. Supplement A gives additional information for cases where temperature stability is not achieved during the test.
/2/	60068-2-78 (2001-08) Environmental testing - Part 2-78: Tests - Test Cab: Damp heat, steady state *(IEC 60068-2-78 replaces the following withdrawn standards: IEC 60068-2-3, test Ca and IEC 60068-2-56, test Cb)*	Provides a test method for determining the suitability of electrotechnical products, components or equipment for transportation, storage and use under conditions of high humidity. The test is primarily intended to permit the observation of the effect of high humidity at constant temperature without condensation on the specimen over a prescribed period. This test provides a number of preferred severities of high temperature, high humidity and test duration. The test can be applied to both heat-dissipating and non-heat dissipating specimens. The test is applicable to small equipment or components as well as large equipment having complex interconnections with test equipment external to the chamber, requiring a set-up time which prevents the use of preheating and the maintenance of specified conditions during the

	Standard	Description
		installation period.
	60068-3-4 (2001-08) Environmental testing - Part 3-4: Supporting documentation and guidance - Damp heat tests	Provides the necessary information to assist in preparing relevant specifications, such as standards for components or equipment, in order to select appropriate tests and test severities for specific products and, in some cases, specific types of application. The object of damp heat tests is to determine the ability of products to withstand the stresses occurring in a high relative humidity environment, with or without condensation, and with special regard to variations of electrical and mechanical characteristics. Damp heat tests may also be utilized to check the resistance of a specimen to some forms of corrosion attack.
/3/	IEC 60654-2 (1979-01), with amendment 1 (1992-09) Operating conditions for industrial-process measurement and control equipment Part 2: Power	Gives the limiting values for power received by land-based and offshore industrial-process measurement and control systems or parts of systems during operation. Maintenance and repair conditions are not considered.
/4/	IEC 61000-4-1 (2000-04) Basic EMC Publication Electromagnetic compatibility (EMC) Part 4: Testing and measurement techniques Section 1: Overview of IEC 61000-4 series	Gives applicability assistance to the users and manufacturers of electrical and electronic equipment on EMC standards within the IEC 61000-4 series on testing and measurement techniques. Provides general recommendations concerning the choice of relevant tests
	IEC 61000-4-11 (1994-06) with amendment 1 (2000-11) Electromagnetic compatibility (EMC) - Part 4-11: Testing and measuring techniques - Voltage dips, short interruptions and voltage variations immunity tests Consolidated Edition: IEC 61000-4-11 (2001-03) Ed. 1.1	This standard defines the immunity test methods and range of preferred test levels for electrical and electronic equipment connected to low voltage power supply networks for voltages dips, short interruptions, and voltage variations. It applies to electrical and electronic equipment having a rated input current not exceeding 16 A per phase. It does not apply to electrical and electronic equipment for connection to DC networks or 400 Hz AC networks.
	IEC 61000-4-4 (1995-01) with Amendment 1 (2000-11) and Amendment 2 (2001-07) Electromagnetic compatibility (EMC) - Part 4: Testing and measurement techniques - Section 4: Electrical fast transient/burst immunity test. Basic EMC Publication	Relates to the immunity requirements and test methods for electrical and electronic equipment to repetitive electrical fast transients. Additionally defines ranges of test levels and establishes test procedures. The object of this standard is to establish a common and reproducible basis for evaluating the performance of electrical and electronic equipment when subjected to repetitive fast transients (bursts), on supply, signal and control ports. The test is intended to

Standard	Description
	demonstrate the immunity of electrical and electronic equipment when subjected to types of transient disturbances such as those originating from switching transients (interruption of inductive loads, relay contact bounce, etc.). The standard defines: - test voltage waveform; - range of test levels; - test equipment; - test set-up; - test procedure.
IEC 61000-4-5: 1995 + A2:2000 (2001-12) Electromagnetic compatibility (EMC) Part 4: Testing and measurement techniques Section 5: Surge immunity test.	It relates to the immunity requirements, test methods, and range of recommended test levels for equipment to unidirectional surges caused by overvoltages from switching and lightning transients. Several test levels are defined which relate to different environment and installation conditions. These requirements are developed for and are applicable to electrical and electronic equipment. The object of this section is to establish a common reference for evaluating the performance of equipment when subjected to high-energy disturbances on the power and interconnection lines.
IEC 61000-4-2 (1995-01) with amendment 1 (1998-01) Basic EMC Publication Electromagnetic compatibility (EMC) Part 4: Testing and measurement techniques Section 2: Electrostatic discharge immunity test. Consolidated Edition: IEC 61000-4-2 (2001-04) Ed. 1.2 This publication is based on IEC 60801-2 (second edition: 1991).	It relates to the immunity requirements and test methods for electrical and electronic equipment subjected to static electricity discharges, from operators directly, and to adjacent objects. It additionally defines ranges of test levels which relate to different environmental and installation conditions and establishes test procedures. The object of this standard is to establish a common and reproducible basis for evaluating the performance of electrical and electronic equipment when subjected to electrostatic discharges. In addition, it includes electrostatic discharges which may occur from personnel to objects near vital equipment.
IEC 61000-4-3 (1995-03), with amendment 1 (1998-06) Electromagnetic compatibility (EMC) Part 4: Testing and measurement techniques Section 3: Radiated, radio-frequency, electromagnetic field immunity test IEC FDIS 61000-4-3, Ed. 2 (2001-11) Consolidated Edition: IEC 61000-4-3 (2002-09) Ed. 2.1	Applies to the immunity of electrical and electronic equipment to radiated electromagnetic energy. Establishes test levels and the required test procedures. Establishes a common reference for evaluating the performance of electrical and electronic equipment when subjected to radio-frequency electromagnetic fields.

	Standard	Description
	IEC 61000-4-6 (1996-04), with Correction1 (1996-10) and Amendment 1 (2000-11) Electromagnetic compatibility (EMC) Part 4: Testing and measurement techniques Section 6: Immunity to conducted disturbances, induced by radio-frequency fields Consolidated Edition: IEC 61000-4-6 (2001-04) Ed. 1.1	Relates to the conducted immunity requirements of electrical and electronic equipment to electromagnetic disturbances coming from intended radio-frequency (RF) transmitters in the frequency range 9 kHz up to 80 MHz. Equipment not having at least one conducting cable (such as mains supply, signal line or earth connection), which can couple the equipment to the disturbing RF fields is excluded. This standard does not intend to specify the tests to be applied to particular apparatus or systems. Its main aim is to give a general basic reference to all concerned product committees of the IEC. The product committees (or users and manufacturers of equipment) remain responsible for the appropriate choice of the test and the severity level to be applied to their equipment.
/5/	ISO/ 7637-1 (2002) (*) Road vehicles - Electrical disturbance from conducting and coupling - Part 1: Definitions and general considerations	Defines basic terms used in the various parts for electrical disturbance by conduction and coupling. Gives also general information relating to the whole International Standard and common to all parts.
	ISO 7637-2 (1990) Road vehicles - electrical disturbance by conducting and coupling Part 2: Commercial vehicles with nominal 24 V supply voltage - Electrical transient conduction along supply lines only	Specifies test methods and procedures to ensure the compatibility to conducted electrical transients of equipment installed on commercial vehicles fitted with a 24 V electrical system. It describes bench tests for both the injection and measurement of transients.
	ISO 7637-3 (1995) with correction 1 (1995) Road vehicles - Electrical disturbance by conducting and coupling - Part 3: Passenger cars and light commercial vehicles with nominal 12 V supply voltage and commercial vehicles with 24 V supply voltage - Electrical transient transmission by capacitive and inductive coupling via lines other than supply lines	establishes a common basis for the evaluation of the EMC of electronic instruments, devices and equipment in vehicles against transient transmission by coupling via lines other than supply lines. The test intention is the demonstration of the immunity of the instrument, device or equipment when subjected to coupled fast transient disturbances, such as those caused by switching (switching of inductive loads, relay contact bounce, etc.)
	ISO/DIS CD 7637-2.3 (2003) Road vehicles - electrical disturbance by conducting and coupling . Part 2: Electrical transient conduction along supply lines only	Specifies test methods and procedures to ensure the compatibility to conducted electrical transients of equipment installed on passenger cars and light commercial vehicles fitted with a 12 V electrical system or installed on commercial vehicles fitted with

Standard	Description
	24 V electrical system. It describes bench tests for both the injection and measurement of transients. It is applicable to all types of road vehicles independent of the propulsion system (e.g. spark ignition or diesel engine, electric motor).

(*) At the time of drafting the International Document OIML ID 11, there are 2 different standards
with the number ISO 7637-1: ((will be adapted later))

ISO 7637-1 (2002) Road vehicles - Electrical disturbance from conducting and coupling - Part 1:
Definitions and general considerations
This standard replaced the earlier standard:
ISO 7637-0 (1990) Road vehicles - electrical disturbance by conducting and coupling, Part 0:
Definitions and general

ISO 7637-1 (1990) Road vehicles - electrical disturbance by conducting and coupling, Part 1:
Passenger cars and light commercial vehicles with nominal 12 V supply voltage - Electrical
transient conduction along supply lines only
This standard is intended to be replaced by the present draft:
ISO/DIS CD 7637-2.3 (2003) Road vehicles - electrical disturbance by conducting and coupling .
Part 2: Electrical transient conduction along supply lines only.